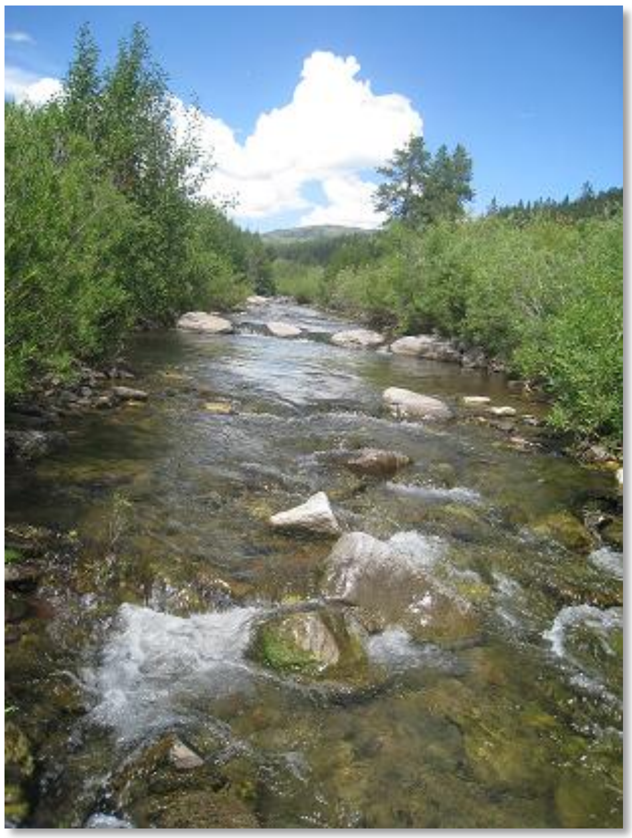
Palisades Subbasin Total Maximum Daily Loads

2013 Addendum and Five-Year Review



Final

State of Idaho
Department of Environmental Quality

November 2013

Palisades Subbasin
Total Maximum Daily Loads

2013 Addendum and Five-Year Review

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Acknowledgments

Cover photo of North Fork Pine Creek in July 2010 (Aaron Swift, Idaho Department of Environmental Quality).

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Abbreviations, Acronyms, and Symbols

§303(d)	refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section
§	section (usually a section of federal or state rules or statutes)
ATV	all-terrain vehicle
AU	assessment unit
BAG	basin advisory group
BMP	best management practice
BURP	Beneficial Use Reconnaissance Program
CFR	Code of Federal Regulations (refers to citations in the federal administrative rules)
cfs	cubic feet per second
cfu	colony forming unit
CGP	Construction General Permit
CW	cold water
CWA	Clean Water Act
DEQ	Idaho Department of Environmental Quality
DWS	domestic water supply
EPA	United States Environmental Protection Agency
GIS	geographic information system
IDAPA	refers to citations of Idaho administrative rules
IDFG	Idaho Department of Fish and Game
IDPR	Idaho Department of Parks and Recreation
LA	load allocation
LC	load capacity
mL	milliliter
mm	millimeter
MOS	margin of safety
NB	natural background
NPDES	National Pollutant Discharge Elimination System
PCR	primary contact recreation
PIT	passive integrated transponder
RAC	Eastern Idaho Resource Advisory Committee
SBA	subbasin assessment
SCR	secondary contact recreation
SS	salmonid spawning
SWPPP	stormwater pollution prevention plan
TMDL	total maximum daily load
TU	Trout Unlimited
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WAG	watershed advisory group
WLA	wasteload allocation

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Executive Summary

This total maximum daily load (TMDL) analysis has been developed to address impaired water bodies in the Palisades Subbasin. This document is an addendum to the *Palisades Subbasin Assessment and Total Maximum Daily Load Allocations* (DEQ 2001), approved by the US Environmental Protection Agency (EPA) in 2001, and also serves as the TMDL 5-year review.

Regulatory Requirements

This document has been prepared in accordance with federal and state regulations. The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. Currently this list is published every 2 years as the list of Category 5 waters in the Integrated Report. For waters identified on this list, states and tribes must develop a TMDL for the pollutants, set at a level to achieve water quality standards.

Idaho Statute 39-3611(7) requires a 5-year cyclic review process for Idaho TMDLs. Along with presenting a TMDL addendum, this report documents the review of an approved Idaho TMDL and implementation plan, considers the most current and applicable information in conformance with Idaho Statute 39-3607, evaluates the appropriateness of the TMDL to current watershed conditions, and involves consultation with the watershed advisory group.

Subbasin at a Glance

Palisades Subbasin (hydrologic unit code 17040104) drains to the South Fork Snake River in eastern Idaho. Public lands, predominantly forested, cover over two-thirds of the subbasin. The private lands are mainly rural agricultural lands. Impaired water quality in the Palisades Subbasin is primarily caused by instream erosion and deposition of excess fine sediment. Elevated sediment levels in the Palisades Subbasin are generally caused by recreation, roadways, and livestock grazing in riparian areas.

This addendum addresses 10 assessment units (AUs) listed in Category 5 of Idaho's current 2010 Integrated Report (DEQ 2011) (Figure A). The subbasin assessment examines the water quality status, extent of impairment, and causes of water quality limitation throughout the subbasin. The TMDL analyses quantify pollutant loads and allocate load reductions needed to return listed waters to a condition meeting water quality standards. This document also provides a review of previously approved TMDLs for the subbasin and past and ongoing implementation efforts.

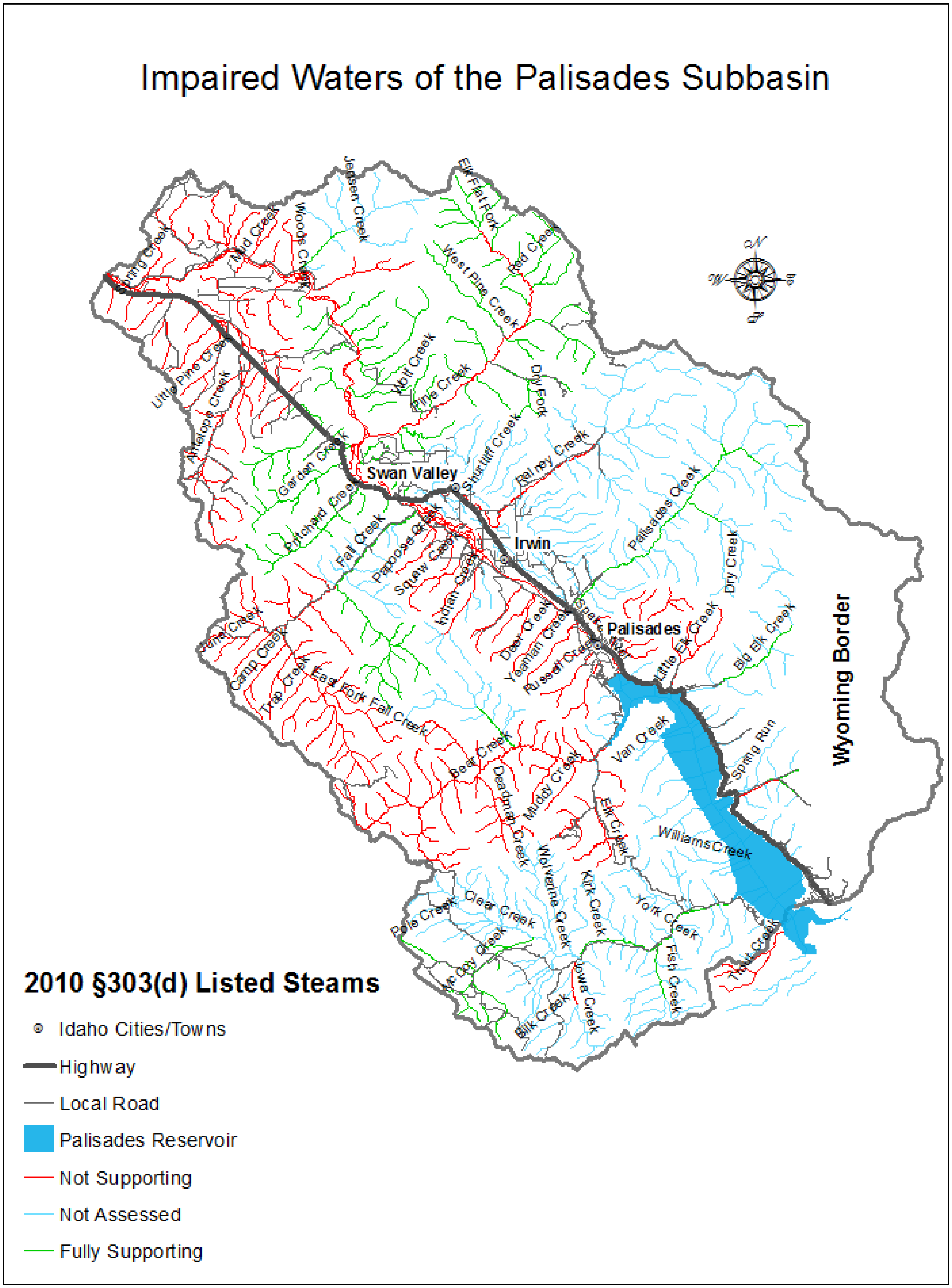

Figure A. Impaired waters listed in the 2010 Integrated Report.

Key Findings

During this analysis, 10 AUs listed as impaired waters in Category 5 of *Idaho's 2010 Integrated Report* were investigated for suspected water quality impairments (DEQ 2011). Investigation by the Idaho Department of Environmental Quality (DEQ) showed that sediment was the main cause of impairment and that excess erosion in this subbasin is more significant from unstable, eroding streambanks than from upland erosion. Excess streambank erosion generally occurs during snowmelt and runoff in early spring, so DEQ measured the stability characteristics of streambanks at bank-full widths to determine the rate of excess erosion above natural background levels. A bacteria TMDL was written for Rainey Creek requiring a 50% reduction. This investigation showed that water quality targets are met in Squaw Creek, Iowa Creek, Trout Creek, South Fork Indian Creek, main fork Indian Creek, Indian Creek (located off Fall River Road), North Fork Pine Creek, and Black Canyon Creek. Excess sediment was determined to be impairing water quality in two assessment units of the Palisades Subbasin, requiring a 41% reduction on Hawley Gulch Creek, 57% reduction on Table Rock Canyon Creek, and 79% reduction on lower Indian Creek. Assessment outcomes for pollutants are given in Table A.

Public Participation and Public Comments

The South Fork Snake WAG played an integral part in helping with the TMDL addendum. DEQ held WAG meetings in spring and fall 2011 to let WAG members express their concerns with ongoing issues in the Palisades Subbasin. DEQ also presented the TMDL addendum and 5-year review to the Upper Snake Basin Advisory Group (BAG) in spring 2012. The BAG did not express major concerns and were pleased with the document.

The public comment period for the Palisades Subbasin TMDL 2013 Addendum and Five Year Review was initiated April 30, 2013, with a deadline for submitting comments set for 5 p.m. MDT on May 30, 2013. Notice of the request for public comments was published in the Idaho Falls *Post Register*, the Jefferson County *Jefferson Star*, and on the DEQ website: deq.idaho.gov. No public comments were received during the 30 day public comment period.

Table A. Summary of assessment outcomes for waters listed in the 2010 Integrated Report (DEQ 2011).

Water Body Segment/ Assessment Unit	Listed Pollutant(s)	TMDL Completed	Recommended Changes to Next Integrated Report	Justification
Snake River—Black Canyon Creek to river mile 856 ID17040104SK001_02	Combined Biota/Habitat Bioassessments	Yes	Delist for Combined Biota/Habitat Bioassessments. List in Category 4a for Sediment.	Excess sediment causing impairment. Sediment load allocation developed.
Snake River—Palisades Reservoir Dam to Fall Creek ID17040104SK008_02	Combined Biota/Habitat Bioassessments; sedimentation/Siltation	No	Retain in Category 5 for Combined Biota/Habitat Bioassessments and Sedimentation/Siltation. .	Meets water quality targets. No pollutant pathways or sources of impairment found. Forested/recreation lands. BURP or other biological metric will be conducted to determine if beneficial uses are now fully supported.
Bear Creek—North Fork Bear Creek to Palisades Reservoir ID17040104SK011_02	Combined Biota/Habitat Bioassessments	No	Delist for Combined Biota/Habitat Bioassessments. Keep listed in Category 4a for Sediment.	Sediment was found to be the pollutant and sediment TMDL was approved by EPA in 2001.
Bear Creek—source to North Fork Bear Creek ID17040104SK013_03	Combined Biota/Habitat Bioassessments	No	Delist for Combined Biota/Habitat Bioassessments. Keep listed in Category 4a for Sediment.	Sediment was found to be the pollutant and sediment TMDL was approved by EPA in 2001.
Iowa Creek—source to mouth ID17040104SK020_03	Combined Biota/Habitat Bioassessments; Habitat Assessment (streams); Cause Unknown	No	Delist for Combined Biota/Habitat Bioassessments, Habitat assessment (streams), and Cause Unknown. Move to Category 2.	Meets water quality targets; no pollutant pathways or sources of impairment found. Appears to be listing error based on ADB BURP info
Trout Creek—source to mouth ID17040104SK022_02	Sedimentation/Siltation	No	Delist for Sedimentation/ Siltation. Move to Category 2.	Meets water quality targets. No pollutant pathways or sources of impairment found. Forested/recreation lands. Listing error due to miscalculation of SFI BURP metric.
Indian Creek—Idaho/Wyoming border to Palisades Reservoir ID17040104SK024_04	Combined Biota/Habitat Bioassessments	Yes	Delist for Combined Biota/Habitat Bioassessments. Move to Category 4a.	Sediment determined to be the impairment; sediment load allocation developed.
Rainey Creek—source to mouth ID17040104SK028_04	Combined Biota/Habitat Bioassessments; Escherichia coli	Yes	List in Category 4a for *E. coli*.	Maintain Combined Biota/Habitat Bioassessments listing until further analysis can be completed.or BURP confirms beneficial use support. *E. coli* TMDL completed.

Water Body Segment/ Assessment Unit	Listed Pollutant(s)	TMDL Completed	Recommended Changes to Next Integrated Report	Justification
Pine Creek—source to mouth ID17040104SK029_03	Cause Unknown	No	Delist for Cause Unknown. Change to Combined Biota/Habitat Bioassessments and retain in Category 5	Meets water quality targets; no pollutant pathways or sources of impairment found. Forested/recreation lands. BURP will be conducted to determine if beneficial uses are now fully supported or other biological stressor analysis. Little to no site access and BURP not conducted multiple years.
Black Canyon Creek—source to mouth ID17040104SK030_02	Sedimentation/Siltation	No	Delist for Sedimentation/Siltation. Move to Category 2	Meets sediment water quality targets. No pollutant pathways or sources of impairment found. Forested/recreation lands. Passed BURP in 2001 .

1 Subbasin Assessment—Watershed Characterization

This document presents an addendum to and 5-year review of the *Palisades Subbasin Assessment and Total Maximum Daily Load Allocations* (DEQ 2001), approved by the US Environmental Protection Agency (EPA) in 2001, addressing additional assessment units (AUs) in Category 5 of the 2010 Integrated Report and implementation activities taking place in the subbasin (DEQ 2011).

1.1 Introduction—Regulatory Requirements

This document was prepared in compliance with federal and state regulatory requirements. The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible.

Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. This list is currently published every 2 years as the list of Category 5 waters in the Integrated Report. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards.

This document addresses 10 AUs in the Palisades Subbasin (hydrologic unit code 17040104) listed in Category 5 of *Idaho's 2010 Integrated Report* (DEQ 2011) (Figure 1). During this TMDL analysis, the Idaho Department of Environmental Quality (DEQ) also investigated 14 AUs that are believed to be impaired but are not §303(d) listed. The subbasin assessment (sections 1–3) examines the status, extent of impairment, and causes of water quality limitation throughout the subbasin. Section 4 summarizes monitoring and implementation activities in the subbasin. The TMDL analyses (section 5) quantify pollutant loads and allocate load reductions needed to return listed waters to a condition meeting water quality standards.

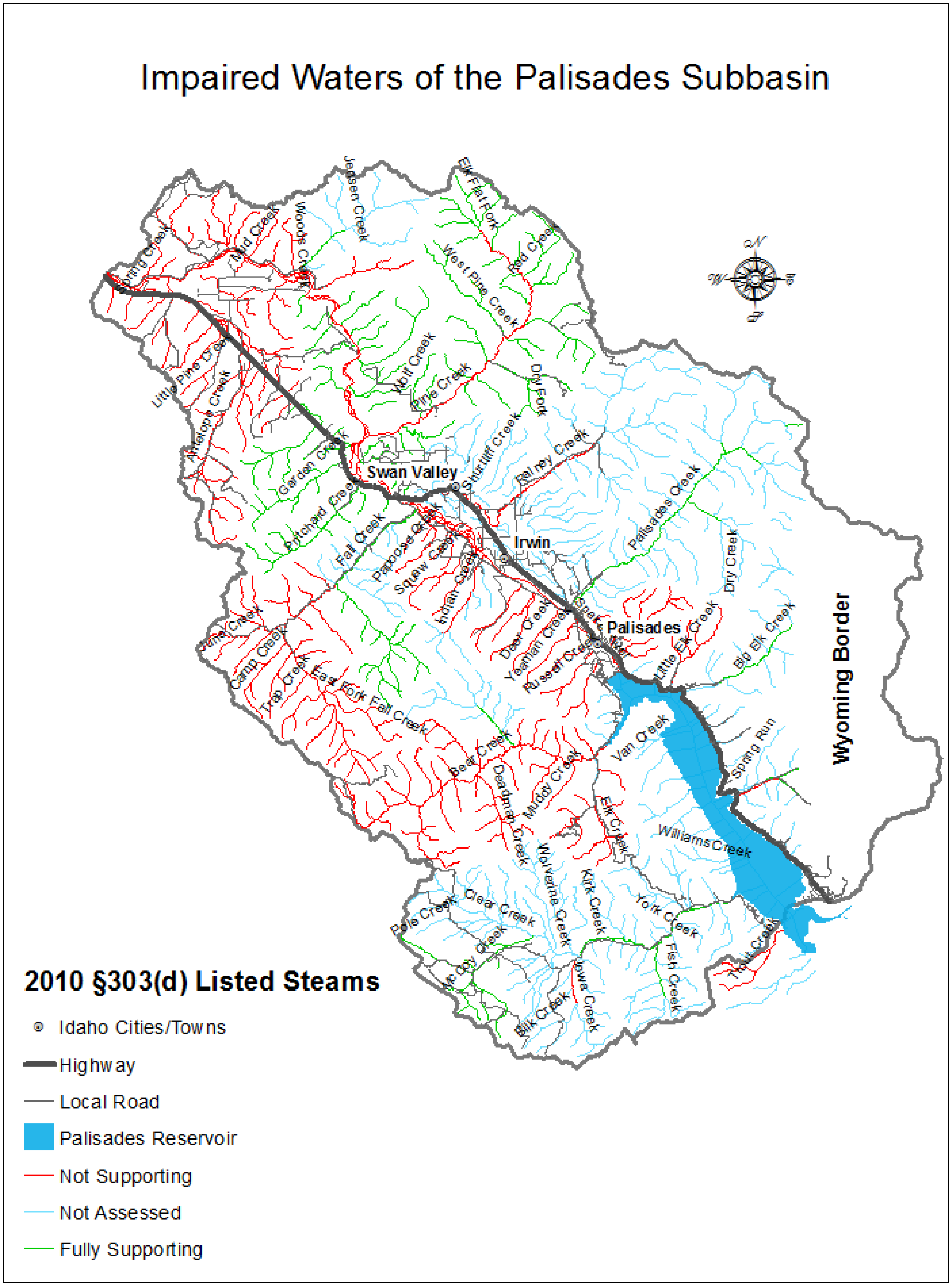

Figure 1. Impaired waters listed in the 2010 Integrated Report.

Idaho Code 39-3611(7) requires a 5-year cyclic review process for Idaho TMDLs:

> The director shall review and reevaluate each TMDL, supporting subbasin assessment, implementation plan(s) and all available data periodically at intervals of no greater than five (5) years. Such reviews shall include the assessments required by section 39-3607, Idaho Code, and an evaluation of the water quality criteria, instream targets, pollutant allocations, assumptions and analyses upon which the TMDL and subbasin assessment were based. If the members of the watershed advisory group, with the concurrence of the basin advisory group, advise the director that the water quality standards, the subbasin assessment, or the implementation plan(s) are not attainable or are inappropriate based upon supporting data, the director shall initiate the process or processes to determine whether to make recommended modifications. The director shall report to the legislature annually the results of such reviews.

This report is intended to meet the intent and purpose of Idaho Code 39-3611(7). The report documents the review of an approved Idaho TMDL and implementation plan, considers the most current and applicable information in conformance with Idaho Code 39-3607, evaluates the appropriateness of the TMDL to current watershed conditions, and includes consultation with the watershed advisory group (WAG). Final decisions for TMDL modifications are decided by the DEQ director. Approval of TMDL modifications is decided by EPA, with consultation by DEQ.

1.2 Physical and Biological Characteristics

A detailed discussion of the physical and biological characteristics of the subbasin—including climate, subbasin characteristics, subwatershed characteristics, and stream characteristics—is provided in the Palisades subbasin assessment (SBA) and TMDL (DEQ 2001).Relevant information pertaining to streams listed as impaired and any updated information is included throughout this document.

1.3 Cultural Characteristics

A detailed cultural discussion is provided in the Palisades SBA and TMDL (DEQ 2001).

1.3.1 Landownership and Population

Most of this subbasin lies within Bonneville County, with about 5% in both Madison and Jefferson Counties. Figure 2 shows the current distribution of landownership for this subbasin.

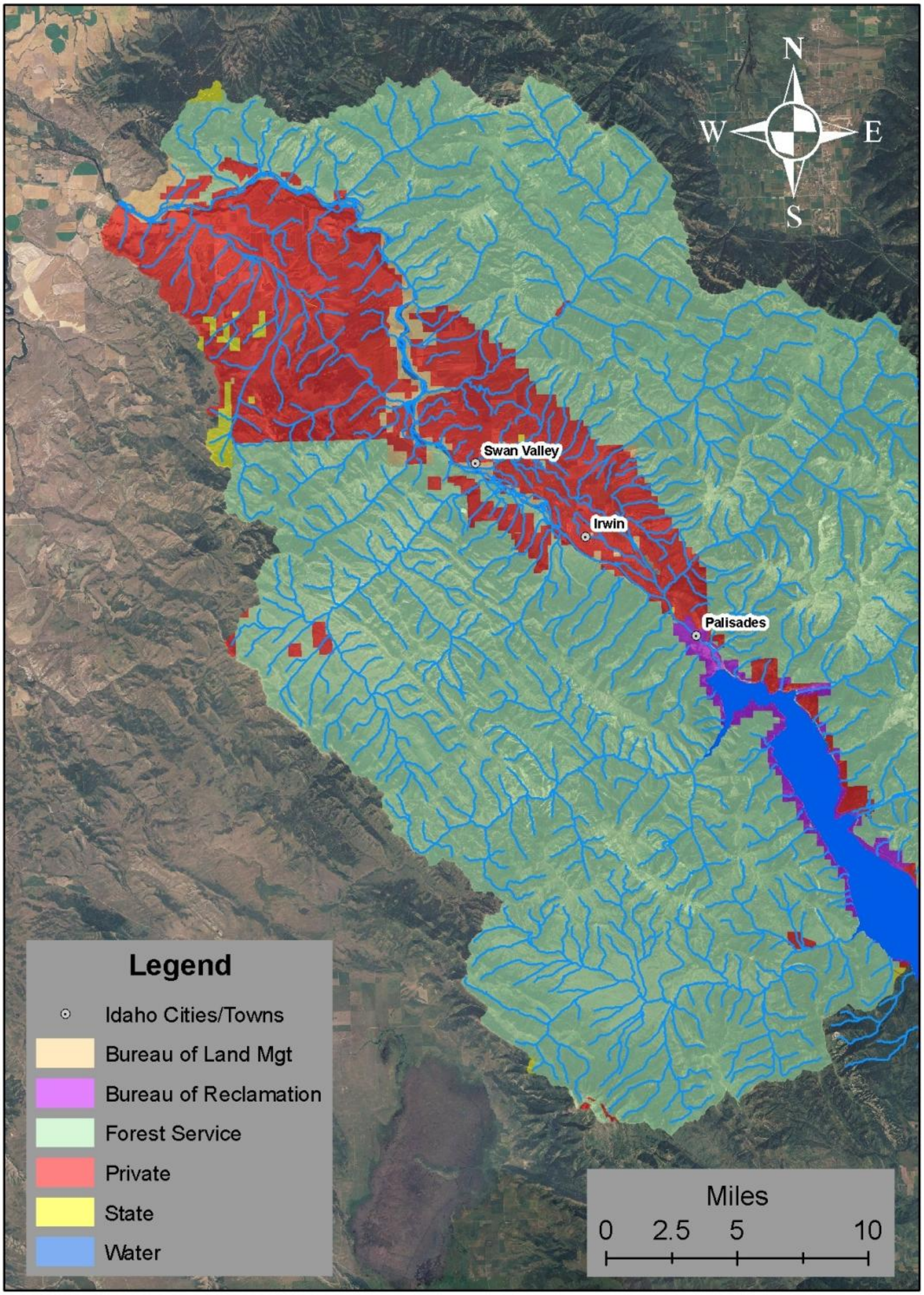

Figure 2. Palisades Subbasin landownership.

2 Subbasin Assessment—Water Quality Concerns and Status

2.1 Water Quality Limited Assessment Units Occurring in the Subbasin

Section 303(d) of the CWA states that waters unable to support their beneficial uses and not meeting water quality standards must be listed as water quality limited waters. Subsequently, these waters are required to have TMDLs developed to bring them into compliance with water quality standards.

2.1.1 Idaho's Integrated Report

Table 1 shows the pollutants listed and the basis for listing for each §303(d)-listed AU in this analysis that has been added since publication of the SBA and TMDL approved by EPA in 2001.

Table 1. Assessment units listed in the 2010 Integrated Report as impaired by pollutants.

Assessment Unit Name	Assessment Unit Number	Impaired Stream Miles	Pollutants	Listing Basis
Snake River—Black Canyon Creek to river mile 856	ID17040104SK001_02	48.29	Combined Biota/Habitat Bioassessments (cause unknown)	2002 §303(d) list
Snake River—Palisades Reservoir Dam to Fall Creek	ID17040104SK008_02	77.84	Combined Biota/Habitat Bioassessments (cause unknown); Sedimentation/Siltation	1998 §303(d) list 2008
Bear Creek—North Fork Bear Creek to Palisades Reservoir	ID17040104SK011_02	35.62	Combined Biota/Habitat bioassessments (cause unknown)	1998 §303(d) list
Bear Creek—source to North Fork Bear Creek	ID17040104SK013_03	6.74	Combined Biota/Habitat Bioassessments (cause unknown)	1998 §303(d) list
Iowa Creek—source to mouth	ID17040104SK020_03	2.32	Combined Biota/Habitat Bioassessments; Habitat Assessment (streams); Cause Unknown	2008 §303(d) list
Trout Creek—source to mouth	ID17040104SK022_02	8.33	Sedimentation/Siltation	2008 §303(d) list
Indian Creek—Idaho/Wyoming border to Palisades Reservoir	ID17040104SK024_04	2.21	Combined Biota/Habitat Bioassessments	2002 §303(d) list
Rainey Creek—source to mouth	ID17040104SK028_04	12.46	Combined Biota/Habitat Bioassessments; *E. coli (pathogens)*	2010 §303(d) list 2002
Pine Creek—source to mouth	ID17040104SK029_03	16.17	Cause Unknown	2008 §303(d) list
Black Canyon Creek—source to mouth	ID17040104SK030_02	7.08	Sedimentation/Siltation	2008 §303(d) list

Not all of the water bodies listed in Category 5 of the 2010 Integrated Report require a TMDL. However, a thorough investigation using the available data was performed before this conclusion was made.

2.2 Applicable Water Quality Standards and Beneficial Uses

Idaho water quality standards, defined in IDAPA 58.01.02, designate beneficial uses and set water quality goals for waters of the state. Idaho water quality standards require that surface waters of the state be protected for *beneficial uses*, wherever attainable (IDAPA 58.01.02.054). These beneficial uses are interpreted as existing uses, designated uses, and presumed uses as described briefly in the following paragraphs. The *Water Body Assessment Guidance* (Grafe et al. 2002) provides a more detailed description of beneficial use identification for use assessment purposes.

2.2.1 Existing Uses

Existing uses under the CWA are "those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards" (40 CFR 131.3). The existing instream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.051). Existing uses include uses actually occurring, whether or not the level of water quality to fully support the uses exists. A practical application of this concept would be to apply the existing use of salmonid spawning to a water body that could support salmonid spawning but is not due to other factors, such as dams blocking migration.

2.2.2 Designated Uses

Designated uses under the CWA are "those uses specified in water quality standards for each water body or segment whether or not they are being attained" (40 CFR 131.3). Designated uses are those uses officially recognized by the state. In Idaho, these designated uses include aquatic life support, recreation in and on the water, domestic water supply, and agricultural uses. Water quality must be sufficiently maintained to meet the most sensitive use.

Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protecting an existing higher quality use such as cold water aquatic life or salmonid spawning.

Designated uses are specifically listed for water bodies in Idaho in tables in the Idaho water quality standards (see IDAPA 58.01.02.010.24 and 02.100–160 in addition to citations for existing uses).

2.2.3 Presumed Uses

In Idaho, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. These undesignated uses are to be designated. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called "presumed uses," DEQ applies the numeric cold water aquatic life criteria and primary or secondary contact recreation criteria to undesignated waters.

If an existing use (e.g., salmonid spawning) exists in addition to these presumed uses, then the additional numeric criteria for salmonid spawning would also apply (e.g., intergravel dissolved oxygen, temperature) because of the requirement to protect levels of water quality for existing uses. Table 2 and Table 3 display each AU's beneficial uses; all are presumed uses with the exception of Garden Creek (ID17040104SK003_02), which has designated uses.

Table 2. Beneficial uses of impaired waters listed in 2010 Integrated Report.

Assessment Unit Name	Assessment Unit Number	Beneficial Uses[a]
Snake River—Black Canyon Creek to river mile 856	ID17040104SK001_02	CW, SS, PCR, DWS
Snake River—Palisades Reservoir Dam to Fall Creek	ID17040104SK008_02	CW, SS, PCR, DWS
Bear Creek—North Fork Bear Creek to Palisades Reservoir	ID17040104SK011_02	CW, PCR, SCR
Bear Creek—source to North Fork Bear Creek	ID17040104SK013_03	CW, PCR, SCR
Iowa Creek—source to mouth	ID17040104SK020_03	CW, PCR, SCR
Trout Creek—source to mouth	ID17040104SK022_02	CW, PCR, SCR
Indian Creek—Idaho/Wyoming border to Palisades Reservoir	ID17040104SK024_04	CW, PCR, SCR
Rainey Creek—source to mouth	ID17040104SK028_04	CW, PCR, SCR
Pine Creek—source to mouth	ID17040104SK029_03	CW, PCR, SCR
Black Canyon Creek—source to mouth	ID17040104SK030_02	CW, PCR, SCR

[a] CW – cold water, SS – salmonid spawning, PCR – primary contact recreation, DWS – domestic water supply, SCR – secondary contact recreation

Table 3. Palisades Subbasin beneficial uses of assessed, non-§303(d) listed streams.

Assessment Unit Name	Assessment Unit Number	Beneficial Uses[a]
Garden Creek	ID17040104SK003_02	CW, SS, PCR, DWS
Pritchard Creek	ID17040104SK004_02	CW, PCR, SCR
Fall Creek	ID17040104SK005_04	CW, PCR, SCR
South Fork Fall Creek	ID17040104SK007_02 and ID17040104SK007_03	CW, PCR, SCR
North Fork Bear Creek	ID17040104SK012_03	CW, PCR, SCR
McCoy Creek	ID17040104SK014_04	CW, PCR, SCR
	ID17040104SK015_04	CW, PCR, SCR
	ID17040104SK019_03	CW, PCR, SCR
Fish Creek	ID17040104SK021_03	CW, PCR, SCR
Big Elk Creek	ID17040104SK025_04	CW, PCR, SCR
Palisades Creek	ID17040104SK027_03	CW, PCR, SCR
Pine Creek	ID17040104SK029_02	CW, PCR, SCR
Burnt Canyon Creek	ID17040104SK031_03	CW, PCR, SCR

[a] CW – cold water, SS – salmonid spawning, PCR – primary contact recreation, DWS – domestic water supply, SCR – secondary contact recreation

2.3 Criteria to Support Beneficial Uses

Beneficial uses are protected by a set of criteria, which include *narrative* criteria for pollutants such as sediment and nutrients and *numeric* criteria for pollutants such as bacteria (IDAPA 58.01.02.200 and 58.01.02.250).

The narrative sediment criterion is listed in IDAPA 58.01.02.200.08:

> Sediment shall not exceed quantities specified in Sections 250 and 252, or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Section 350.

The narrative nutrient criterion is listed in IDAPA 58.01.02.200.06:

> Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses.

Table 4 details the numeric criteria applicable to impaired waters in the Palisades Subbasin.

Table 4. Numeric criteria to support beneficial uses for applicable water quality parameters.

Water Quality Parameter	Designated and Existing Beneficial Uses			
	Primary Contact Recreation	Secondary Contact Recreation	Cold Water Aquatic Life	Salmonid Spawning
	Water Quality Standards: IDAPA 58.01.02.250			
Bacteria, pH, and dissolved oxygen	Less than 126 *E. coli*/100 mL[a] as a geometric mean of 5 samples over 30 days; no sample greater than 406 *E. coli*/100 mL	Less than 126 *E. coli*/100 mL as a geometric mean of 5 samples over 30 days; no sample greater than 576 *E. coli*/100 mL	—	—

Note: A unit conversion chart is provided in Appendix A.
[a] *Escherichia coli* organisms per 100 milliliters

Figure 3 provides an outline of the stream assessment process for determining the support status of cold water aquatic life, salmonid spawning, and contact recreation beneficial uses.

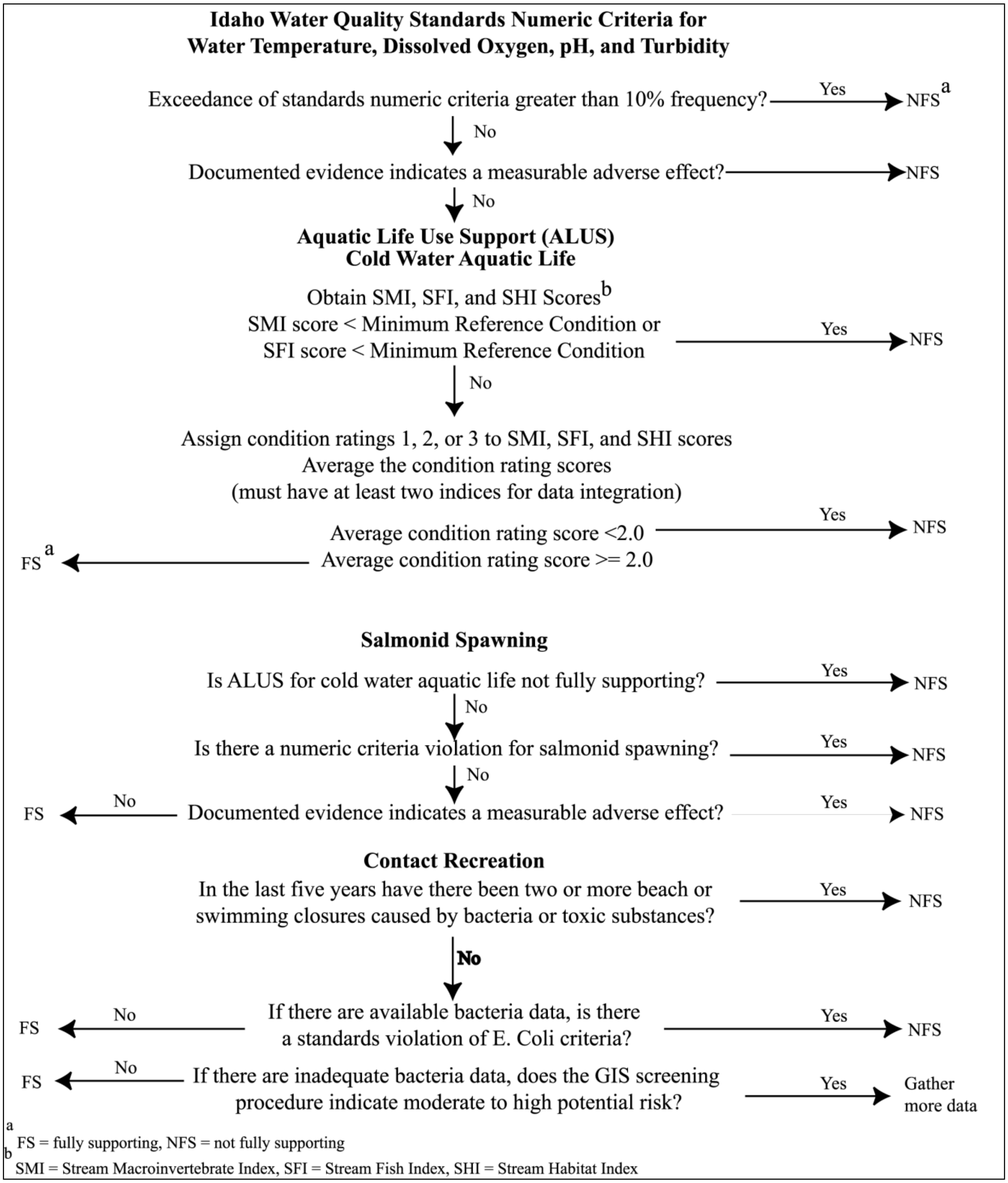

Figure 3. Determination steps and criteria for determining support status of beneficial uses in wadeable streams. (Source: Grafe et al. 2002)

2.4 Summary and Analysis of Existing Water Quality Data

This section provides additional data collected since the Palisades SBA and TMDL (DEQ 2001) was approved by EPA in 2001. Data sources are provided in Appendix B.

2.4.1 Flow Characteristics

A detailed discussion of flow characteristics is provided in the Palisades SBA and TMDL (DEQ 2001). In the tributaries of the Palisades Subbasin, flow is related to climate and precipitation. High flows normally occur in spring during April through June, which is when the highest rate of sediment transport occurs. Streamflow data from US Geological Survey (USGS) gages were analyzed for annual mean discharge at the Heise gage on the South Fork Snake River. The 1.5-year recurrent peak flow on the South Fork Snake River near Heise is 7,000 cubic feet per second (cfs). The annual discharge for the Heise gage was calculated using USGS real-time data for Idaho streamflow (Figure 4). The streamflow cycle is important for sediment TMDLs because bank-full flow is when sediment is transported most efficiently, eroding streambanks at the highest rate of the year. Therefore, the pollutant analyses are made at bank-full width.

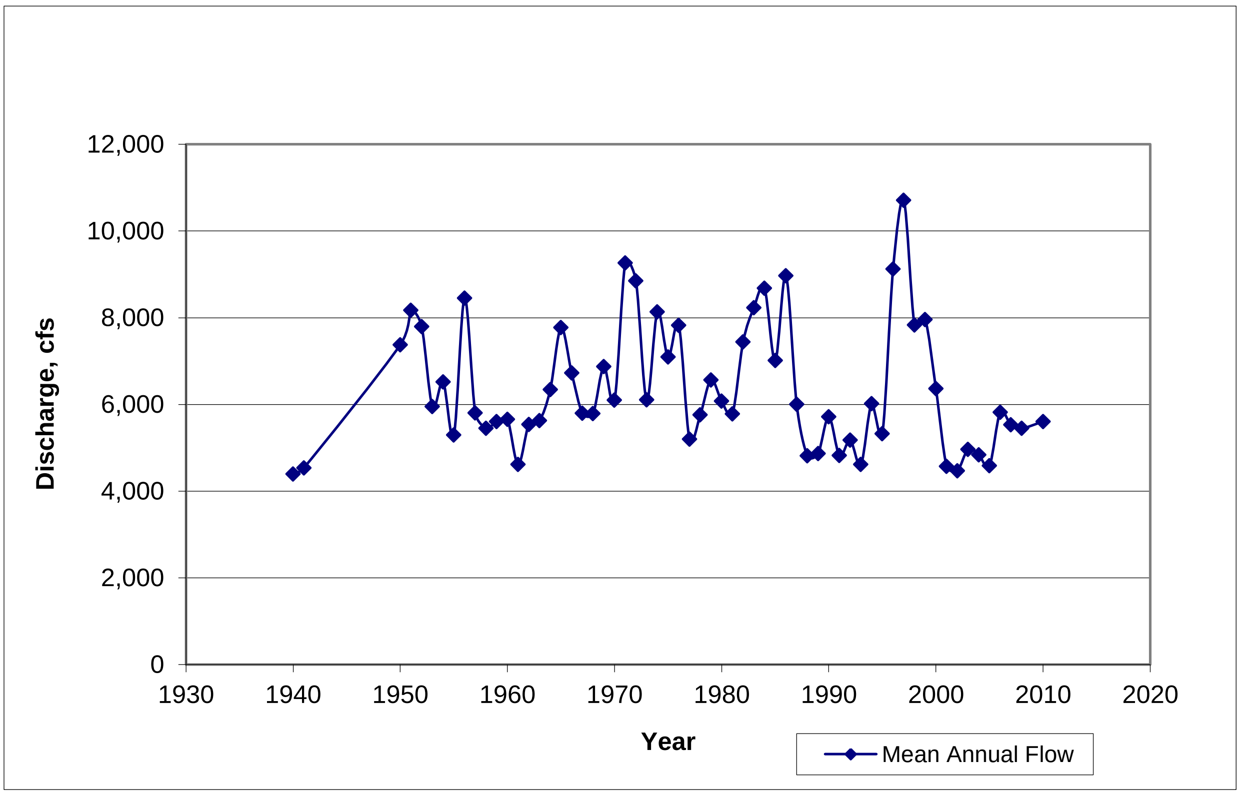

Figure 4. Annual mean discharge at the Heise gage on the South Fork Snake River.

2.4.2 Water Quality Data

Table 5 displays sediment and bacteria data collected since the Palisades SBA and TMDL was approved by EPA in 2001.

Table 5. Water quality data collected since 2001 in the Palisades Subbasin.

Analyte	Location	Current Load	Collection Date	Collecting Agency	Exceeds/Meets Targets
Sediment					
Streambank erosion rate	Hawley Gulch Creek	17 tons/year	7/29/2010	DEQ	Exceeds
	Table Rock Canyon Creek	7 tons/year	7/29/2010	DEQ	Exceeds
	Squaw Creek	0.001 tons/year	7/28/2010	DEQ	Meets
	Iowa Creek	0.008 tons/year	8/30/2010	DEQ	Meets
	Trout Creek	6 tons/year	7/27/2010	DEQ	Meets
	South Fork Indian Creek	0.8 tons/year	7/27/2010	DEQ	Meets
	Main Fork Indian Creek	4 tons/year	7/27/2010	DEQ	Meets
	Lower Indian Creek	43 tons/year	7/27/2010	DEQ	Exceeds
	Indian Creek (Fall Creek Road)	4 tons/year	7/28/2010	DEQ	Meets
	North Fork Pine Creek	0.2 tons/year	7/28/2010	DEQ	Meets
	Black Canyon Creek	0.2 tons/year	7/28/2010	DEQ	Meets
Subsurface fine sediment	Indian Creek (Fall Creek Road)	40% fines	7/28/2010	DEQ	Exceeds
Bacteria					
E. coli	Rainey Creek	200 cfu/100 mL[a]	6/22/10, 7/20/10, 8/24/10, 9/22/10	DEQ	Exceeds

a. colony forming units per 100 milliliters (cfu/100 mL)

DEQ collected streambank erosion rate data for AUs listed in Category 5 of the 2010 Integrated Report during base-flow season in 2010 (DEQ 2011). Of these AUs, only the tributaries of the South Fork Snake River main stem require load allocations for sediment TMDLs. The Rainey Creek AU exceeds the geometric mean criterion for *E. coli* and requires allocations for an *E. coli* TMDL. All other AUs investigated by streambank erosion inventory were found to be meeting their target.

The subsurface fine sediment measurement made by DEQ in 2010 shows that Indian Creek, located along Fall Creek Road, exceeds the target for salmonid spawning at the lower reach.

A summary of the data analysis and conclusions for AUs included in Category 5 of the 2010 Integrated Report follows (DEQ 2011).

ID17040104SK001_02: Snake River—Black Canyon Creek to river mile 856

- Listed for Combined Biota/Habitat Bioassessments.
- Streambank erosion inventory was performed on Hawley Gulch Creek and Table Rock Canyon Creek as representative of 1st- and 2nd-order streams in this AU for extrapolation of data and to inventory previous Beneficial Use Reconnaissance Program

(BURP) sites. Data show that sediment target is exceeded and a load allocation is made in section 5.1.
- Move from “Category 5—Impaired Waters” to “Category 4a—TMDL Completed.” Delist Combined Biota/Habitat Bioassessments as causal pollutant; determined to be sediment (streambank erosion).

ID17040104SK008_02: Snake River—Palisades Reservoir Dam to Fall Creek

- Listed for Combined Biota/Habitat Bioassessments and Sediment/Siltation.
- Streambank erosion inventory was performed on Squaw Creek and Indian Creek as representative of 1st-order streams in this AU for extrapolation of data and to inventory previous BURP site. Data show that Squaw Creek and Indian Creek are meeting sediment targets and exhibit no evidence of other impairment. No other sources or pathways of pollutants were found. Site is forested/recreation land use
- Retain in Category 5 for Combined Biota/Habitat Bioassessments and Sediment/Siltation until BURP can be conducted to confirm beneficial use support.

ID17040104SK011_02: Bear Creek—North Fork Bear Creek to Palisades Reservoir

- Listed for Combined Biota/Habitat Bioassessments.
- Sediment TMDL already approved by EPA in 2001 for this segment, and data show no evidence of other impairment.
- Keep AU in “Category 4a—TMDL Completed” for Sediment. Delist for Combined Biota/Habitat Bioassessments, which had been a placeholder for Sediment.

ID17040104SK013_03: Bear Creek—source to North Fork Bear Creek

- Listed for Combined Biota/Habitat Bioassessments.
- Sediment TMDL already approved by EPA in 2001 for this segment, and data show no evidence of other impairment.
- Keep AU in “Category 4a—TMDL Completed” for sediment. Delist for Combined Biota/Habitat Bioassessments, which had been a placeholder for Sediment.

ID17040104SK020_03: Iowa Creek—source to mouth

- Listed for Combined Biota/Habitat Bioassessments, Habitat Assessments (streams), and Cause Unknown.
- Streambank erosion inventory was performed on Iowa Creek. Data show Iowa Creek is meeting sediment target and exhibits no evidence of other impairment. There are no sources or pathways for nutrients or other pollutants.
- Delist Cause Unknown. This listing was redundant for Combined Biota/Habitat Bioassessments. No sources or pathways for nutrient impairment were identified. Delist Combined Biota/Habitat Bioassessments and Habitat Assessments (streams) as the two are redundant. No evidence of other causal pollutants or impairment.
- Passed BURP with average score of 2 in 2003.
- Delist for Combined Biota/Habitat Bioassessments and move to Category 2.

ID17040104SK022_02: Trout Creek—source to mouth

- Listed for Sediment/Siltation.

- Streambank erosion inventory performed on Trout Creek. Data show that Trout Creek is meeting sediment target and exhibits no evidence of other impairment. There are no sources or pathways for sediment as a pollutant or land use activities causing impairment.
- Move from “Category 5—Impaired Waters” to “Category 2—Waters of the State Attaining Some (Most) Standards.” Delist for Sediment/Siltation.
- 2001 BURP score error made showing SFI of zero(0) when in fact two (2) rainbow trout were noted. SMI of 3 and SHI of 2. Should have been full support.

ID17040104SK024_03: Indian Creek—Idaho/Wyoming border to Palisades Reservoir

- Streambank erosion inventory was performed on South Fork Indian Creek and Main Fork Indian Creek. Data show that South Fork Indian Creek and Main Fork Indian Creek are meeting sediment target and exhibit no evidence of other impairment.
- Maintain in Category 2—Waters of the State Attaining Some (Most) Standards.”

ID17040104SK024_04: Indian Creek—Idaho/Wyoming border to Palisades Reservoir

- Listed for Combined Biota/Habitat Bioassessments.
- Streambank erosion inventory was performed on lower Indian Creek. Data show that the sediment target is exceeded, and a load allocation is made in section 5.1 of this document.
- Retain in Category 5 for Combined Biota/Habitat Bioassessments until BURP can be conducted to determine beneficial use support.

ID17040104SK028_04: Rainey Creek—source to mouth

- Listed for fecal coliform (pathogens) originally and changed to *E. coli* based on current Idaho water quality standards; also listed for Combined Biota/Habitat Bioassessment.
- Samples for *E. coli* taken in 1999 show exceedance of geometric mean criteria during base-flow conditions for contact recreation. The calculated geometric mean was 200 colony forming units per 100 milliliter (cfu/100 mL) (Table 6). Due to protocol error, only four samples were taken in 2010 showing water quality standards being met (Figure 5). Five samples are needed to calculate the geometric mean for compliance with state water quality standards. Due to this error, an *E. coli* TMDL was written for the Rainey Creek AU using the 1999 data.
- Move to “Category 4a—TMDL completed” for *E. coli*.
- Maintain Combined Biota/Habitat Bioassessment listing. Rainey Creek is a high profile fishery. It has received considerable attention from the US Forest Service (USFS) and Trout Unlimited, and a variety of restoration actions have occurred over the past few years recognizing that there may be sources of anthropogenic influences to water quality. Primary problems with Rainey Creek are flow and habitat alteration, likely the cause of failing BURP scores and the resulting §303(d) listing of impairment. A high flow event in 2009 eroded streambanks. Numerous diversions reduced flow and caused impacts to fisheries. DEQ will conduct monitoring and investigations in the future to determine if there is impairment from pollutants or if the problems stem from flow and habitat alteration. It was felt this was more meaningful at this time than developing a TMDL, particularly in light of all the implementation going on with Rainey Creek.

- BURP from 1998 and 2008 shows streambanks at 78% stability and slightly elevated percent fines. A streambank inventory will be conducted before proposing delisting action along with assessment of beneficial use support using BURP or other biological parameters.

Table 6. Bacteria monitoring results for Rainey Creek—1999.

Stream	BURP ID Site	Dates	*E. coli* (colonies/100 mL)
Rainey Creek	1998SIDFC008	8/12–8/26/1999	200 (geometric mean)

Figure 5 illustrates data collected for 2010 Rainey Creek bacteria results. Due to protocol error of only 4 samples being taken, the 1999 *E. coli* data were used for load allocation and TMDL.

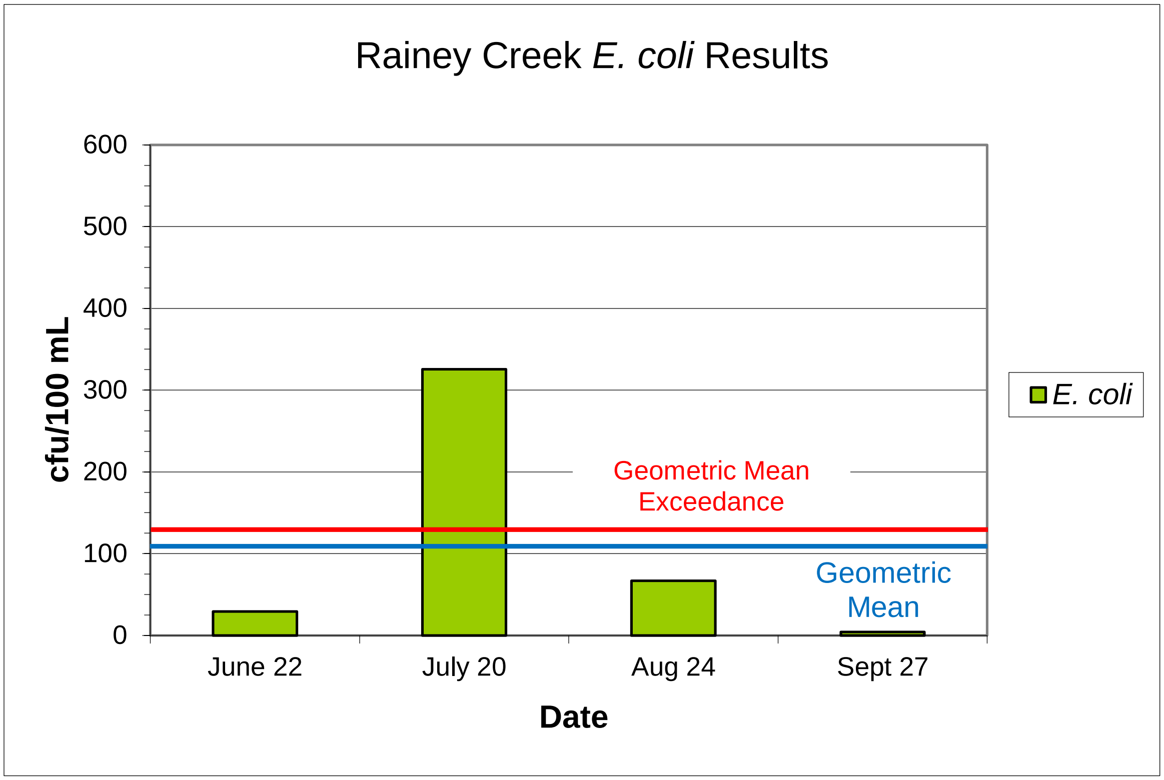

Figure 5. Rainey Creek *E. coli* results—2010.

ID17040104SK029_03: Pine Creek—source to mouth

- Listed for Cause Unknown.
- Streambank erosion inventory was performed on North Fork Pine Creek as representative of 1st-order streams in this AU for extrapolation of data and to inventory previous BURP site. Data show that North Fork Pine Creek is meeting sediment target and exhibits no evidence of other impairment. No sources or pathways for sediment have been identified.
- Retain in Category 5 until BURP or other biological data can confirm full support of beneficial uses.

ID17040104SK030_02: Black Canyon Creek—source to mouth

- Listed for Sediment/Siltation.

- Streambank erosion inventory was performed on Black Canyon Creek as representative of 1st-order streams in this AU for extrapolation of data and to inventory previous BURP site. Data show that Black Canyon Creek is meeting sediment target and exhibits no evidence of other impairment. No sources or pathways of excess sediment were found.
- Move from “Category 5—Impaired Waters” to “Category 2—Waters of the State Attaining Some (Most) Standards.” Delist sediment as causal pollutant.
- Passed BURP in 2001. Listed in error.

2.4.3 Biological and Other Data

A detailed discussion of the assessments based on data collected through BURP is provided in the Palisades SBA and TMDL approved by EPA in 2001 (DEQ 2001).

3 Subbasin Assessment—Pollutant Source Inventory

Pollution within the Palisades Subbasin may be related to land use and can result from excess sediment from streambank erosion. Sediment occurs naturally as a geologic process. Streams move sediment from source areas of high gradient and friable soil material through intermediate elevations and gradients to depositional reaches where sediment is incorporated into the floodplain or transported to larger waters and ultimately the ocean. Land management practices have the potential to accelerate erosion or to alter depositional processes. Sediment in excess of a stream’s ability to transport it becomes pollution. Excess sediment interferes with natural processes that aquatic life depend on and can result in increased instability of natural stream channels, further accelerating erosion.

3.1 Sources of Pollutants of Concern

The primary source of excess sediment in the Palisades Subbasin is streambank erosion. Other potential sources of sediment pollution in any watershed can include roads built too close to streams, improperly maintained roads, return water from ditches laden with sediment to natural waters, erosion from cultivated fields, mass wasting or landslides related to improper engineering techniques, and urban stormwater runoff. Streambank erosion is often a significantly greater long-term source of pollution than these other potential sources.

Sediment from streambank erosion is delivered directly to the stream channel without attenuation or deposition, as is often the case with natural hillslope erosion. Depositional features that result from streambank erosion often further accelerate erosion by redirecting flow into formerly stable banks. Eventually, streambank stability is greatly reduced. As streambanks erode and the width of the stream increases, riparian vegetation and shade decreases. This further decreases streambank stability and increases the thermal load to the stream. Temperature higher than natural background is another pollutant related to streambank stability.

3.1.1 Point Sources

The Palisades Subbasin has no National Pollutant Discharge Elimination System (NPDES) permits located within its boundaries. There are no known point sources; therefore, no wasteload allocation will be developed. No Multi-Sector General Permits were found in EPA’s database for this type of NPDES permit.

3.1.2 Nonpoint Sources

A detailed discussion of nonpoint sources is provided in the Palisades SBA and TMDL approved by EPA in 2001. Nonpoint sources of pollution accumulate over a wide area. They cannot be pin-pointed to any one source but are primarily driven by land use. Grazing in riparian areas and erosion from roads and cultivated fields are common sources of excess sediment delivery to the streams. Recreational activities may also cause nonpoint sources of pollution where streambanks are becoming degraded by access and high use.

3.1.3 Pollutant Transport

Sediment transport is a function of particle size and characteristics of the stream channel, such as morphological type, gradient, and width/depth ratio. Smaller particles transport farther in the channel before coming to rest in depositional areas of the stream. Channel characteristics dictate the velocity of streamflow. Higher velocities cause higher scouring and deposition of particles farther downstream than would occur naturally.

4 Monitoring and Status of Water Quality Improvements

Several water quality improvement projects have been administered by the USFS, Idaho Department of Fish and Game (IDFG), and Trout Unlimited (TU) in the past several years. These projects are summarized below.

4.1 United States Forest Service Projects

The following are several projects the Caribou-Targhee National Forest (Forest) performed in the past 5 years. All projects include best management practices (BMPs) to help improve water quality in the Palisades Subbasin.

4.1.1 2006 Projects

South Fork Fall Creek Trail Closure: The Forest closed 1 mile of user-created motorized trail using signs and barricades (Figure 6). Water bars and drainage features were installed on closed trails to reduce erosion.

Figure 6.
South Fork Fall Creek Trail closure.

Camp Creek Fence: The Forest built a small exclosure around a problem area on Camp Creek to improve streambank stability (Figure 7). Camp Creek is a small tributary to McCoy Creek. Heavy use by wildlife and livestock had degraded the streambanks.

Figure 7. Camp Creek exclosure.

Pritchard Creek: In 2003, the Forest Fisheries Program and TU removed an old irrigation dam, converted the pond bed to a meadow, and restored the stream channel in Pritchard Creek, a tributary to the South Fork Snake River. Cattle were excluded from the project area and water was provided upslope with a solar pump and trough system. The results of ongoing effectiveness monitoring continue to show improvements. In addition to the vegetation that was planted along the stream and in the uplands, native vegetation is naturally re-establishing along the stream (Figure 8). Bulrush and coyote willow are particularly noticeable. The stream channel continues to develop new floodplains, establish gravel beds, and retain less fine sediment, benefiting this Yellowstone cutthroat trout stronghold stream.

Figure 8. Matt Woodard, TU home rivers initiative coordinator, stands in natural wetland vegetation along the restoration reach of Pritchard Creek.

Fall Creek Improvements: In continuing efforts to decrease sediment delivery to Fall Creek, a tributary to the South Fork Snake River, the Palisades Ranger District recreation staff defined acceptable dispersed camp sites along Fall Creek. Boulders were placed at more than a dozen heavily used dispersed campsites (Figure 9). As recreational use in Fall Creek continues to increase, so do the size of these streamside campsites and the disturbed ground associated with them.

During summer 2006, boulders were strategically placed around and gravel was placed on areas acceptable for motorized vehicle and camp trailer parking. This project should decrease erosion and sediment delivery to Fall Creek and benefit important riparian vegetation. It compliments previous work to better manage cattle use along upper Fall Creek with fencing and water developments. The decrease in sedimentation and stream channel improvements are expected to benefit Yellowstone cutthroat trout that inhabit the stream.

Figure 9. A trailer parked extremely close to Fall Creek at a dispersed recreation site in 2005 (top) is an example of a typical encroachment. The placement of boulders at the site in 2006 (bottom) is expected to eliminate this type of impact to the streambanks and vegetation.

The project was a partnership between the Forest, US Fish and Wildlife Service (USFWS), and the Idaho Department of Parks and Recreation (IDPR).

Conant Valley Ranch: In spring 2006, flow was restored to the historic channel of Garden Creek through Conant Valley Ranch, reconnecting an isolated Yellowstone cutthroat trout population upstream on the Forest with the South Fork Snake River (Figure 10). Effectiveness monitoring during the spawning season identified large Yellowstone cutthroat trout from the river spawning in upper Garden Creek, indicating they have found their way back into the stream from the South Fork. Fall effectiveness monitoring found the new Conant Valley Ranch segment of Garden Creek seeded with several age classes of Yellowstone cutthroat trout (probably from upstream). No rainbow trout were observed, but 1-year-old brown trout were collected in a backwater area at the mouth of the stream. Annual monitoring will continue.

Figure 10. Garden Creek flows in its new channel through Conant Valley Ranch during spring 2006.

This project was a partnership between the Forest, TU, Conant Valley Ranch, the Natural Resources Conservation Service, Idaho Transportation Department, and others.

4.1.2 2007 Projects

Highway 31 Protection and Pine-North Pine Creeks Stabilization: The project was located near the confluence of North Fork Pine and Pine Creeks along State Highway 31. The Forest partnered with the Idaho Transportation Department to stabilize nearly 300 feet of eroding banks while protecting the highway and public safety. Streambank erosion was threatening the highway bridge on North Fork Pine Creek and another portion of Hwy 31 along Pine Creek. The project involved constructing boulder vane-type structures (two “J-hooks” and one cross-vane), rebuilding streambanks, and transplanting willows to provide long-term bank stability (Figure 11).

Figure 11. Before (left)—Pine Creek’s eroding bank within 15 feet of Highway 31. After (right)—J-hook vanes and 3–4 feet of constructed streambank.

Red Creek Trail Reroute: This was a National Volunteer Day project. Three small trail reroutes involving approximately 1,700 feet of trail were completed in a single day. Volunteers included members of Teton Valley Trails and Pathways, Teton Freedom Riders, and the Idaho Falls Alpine Club.

Table Rock Road and Trail Closures: The USFS road crew closed or obliterated several roads and user-created trails over approximately 25 acres. This work included the following:

- Closed numerous hill climbs with erosion problems
- Stabilized several stream fords across Table Rock Creek
- Closed the road that extended above the Leaning Fir Gravel Pit
- Closed a nonsystem road that ran from the Burns property to the Table Rock Corral
- Closed a user-created road between Table Rock Corral and Spaulding’s private property
- Improved gate and seasonal closure at the junction of Table Rock and River Road

Cottonwood Bench Road Closure: The Forest closed more than one mile of nonsystem road from the bench above Fullmer (Cottonwood) Boat Landing east to the ridge top.

Four Corners Trail (#034) Relocation: The Forest relocated more than 1.5 miles of trail along the divide between South Fall Creek and North Bear Creek. The old trails were too steep and had severe erosion. New trails were constructed on a more suitable grade. The old trail was closed using native material and water drainage features.

Sheep Creek Trail (#096): The Forest relocated nearly 0.5 miles of trail at the head of the Sheep Creek Drainage. The old trail was too steep and eroding.

Fall Creek Motorized Trail Closures: The Forest closed more than 1 mile of user-created motorized trail in the Fall Creek drainage. Signs and post-and-rail barriers were installed. Water bars were also installed on closed trails.

Elk Mountain Road Drainage: Road (water) drainage was improved on 0.5 miles of road to reduce erosion in the Elk Creek drainage.

4.1.3 2008 Projects

Red Creek Trail Reroute: Building on the work done in 2007, the Teton Basin Trail Crew and Teton Valley Trails and Pathways combined efforts to construct a 0.5-mile reroute on Red Creek in the Big Holes Range (Figure 12). The reroute eliminated two creek crossings on the Red Creek Trail (#241).

Figure 12. Red Creek Trail reroute.

Bear Creek Road Closures: The Forest partnered with Bonneville County to close several user-created spur roads (approximately 1 mile) off Bear Creek Road (058). Some roads accessed Bear Creek and Palisades Reservoir, while others accessed dispersed camp sites. The spurs were ripped and boulders placed to restrict access (Figure 13 and Figure 14).

Figure 13. Road in Red Spring Draw that was ripped and closed.

Figure 14. Road near Bear Creek/Palisades Reservoir that was closed.

Fall Creek Road Reroute: The Forest and Bonneville Power partnered to relocate a portion of Fall Creek Road (077) from the riparian bottom to an upland site (Figure 15).

Figure 15.
Old road on right side of photo near creek bottom was closed off on each end.

Pine Basin Gate and Road Closure: A gate was installed to restrict motorized travel and approximately 1 mile of user-created trails was closed with track-hoe.

South Fork Fall Creek Trail Bridges: Three bridges were constructed in different locations along South Fork Fall Creek Trail (#030). The original stream fords were obliterated. The Eagle Rock ATV Club partnered on this Eagle Scout Project.

Elk Creek Bog Bridges: Ten bog bridges were installed on Big Elk Creek Trail (#097). The bog bridges improved trail conditions and reduced erosion in wet areas where pack and saddle stock would get mired down in the mud. The individual bridge lengths vary from 15 to 30 feet.

Palisades Creek Trail Bridge: A new trail bridge was installed on Palisades Lake Trail (#112) (Figure 16). This bridge will provide passage for livestock and hikers. The bridge was constructed by a contractor. Bridge material was flown in by helicopter and tools and labor were transported by livestock.

Figure 16.
A new trail bridge replaced the eroding ford crossing.

Sheep Creek Road: The Forest and Bonneville County partnered to relocate Upper Sheep Creek Road (260) out of a riparian area to the toe of the hill. The old road was heavily rutted and had widened to over 75 feet where vehicles had moved over to avoid the ruts.

Table Rock Culvert and Trail Closure: TU and the Forest partnered on this project to restore upstream migration for Yellowstone cutthroat trout and stream hydrology on Table Rock Creek (a tributary to the South Fork Snake River). An impassable, under-sized culvert on Forest Service Road 217 was replaced with a bottomless arch (Figure 17). In addition, two illegal all-terrain vehicle (ATV) trails were closed. The riparian area upstream and downstream of the road crossing was recontoured and planted with native vegetation.

Figure 17. Table Rock culvert before (left) and after (right).

South Fork Bear Creek Trail: The original trail located near the creek bottom became impassable due to flooding from several new beaver dams. Approximately 0.3 miles of trail were relocated to the uplands.

Fall Creek Bridge: The Forest and Bonneville County replaced a narrow bridge with a larger structure on River Road (076) (Figure 18).

Figure 18. Fall Creek: Original bridge looking upstream (left) and new bridge looking upstream (right).

Horse Creek Trail Bridge: The Idaho Falls Trail Machine Association and IDPR partnered with the Forest to install a bridge on Fall Creek that replaced an eroding stream ford on the Horse Creek Trail (#140) (Figure 19).

Figure 19. Horse Creek Trail Bridge.

Brockman Major Road Improvement: The project involved graveling and improving drainage along approximately 6 miles of Brockman Road (077) within the McCoy Creek drainage (Figure 20). The road is located in an area of highly erodible soils. Repairing poor road drainage and adding surfacing on a natural surface road have greatly reduced sedimentation entering Clear Creek and its tributaries. By reducing sediment input to these streams, the project has helped improve the watershed, diversity of aquatic species, and trout spawning habitat and contributed to Yellowstone cutthroat trout conservation.

Figure 20. Before (left)—road contributed excessive sediment to stream. After (right)—new crossing prior to placement of gravel surfacing.

4.1.4 2009 Projects

Elk Creek Aquatic Organism Passage: The Forest replaced a crossing of Elk Creek (Forest Service Road 058) in partnership with the Western Native Trout Initiative, USFWS, Eastern Idaho Resource Advisory Committee (RAC), and TU. The crossing was identified during the 2005 Forest culvert fish passage inventory as a barrier to Yellowstone cutthroat trout attempting to migrate up Elk Creek from Palisades Reservoir. It was replaced with a bridge that has appropriate flow capacity, width, and gradient, restoring access to more than 5 miles of quality habitat (Figure 21).

Figure 21. Pre- (left) and post-construction (right) at Elk Creek crossing site, upstream of the Elk Creek/Bear Creek confluence. The impassable, under-capacity culvert was replaced with a bridge.

Wolverine Creek Aquatic Organism Passage: The Forest Fisheries Program worked in partnership with the RAC, USFWS, and TU to restore aquatic organism passage at Wolverine Creek at the South Fork Snake River Road (206). Wolverine Creek is a tributary to the South Fork Snake River with a resident population of Yellowstone cutthroat trout. The under-capacity, damaged culverts were replaced with a concrete component bridge (Figure 22).

Figure 22. Pre- (left) and post-construction (right) at Wolverine Creek crossing site at the South Fork River Road. The impassable, damaged culverts were replaced with a concrete component bridge.

Caboose Culvert Outlet Stabilization and Fish Passage Project: The Forest assisted TU with this project on Rainey Creek. Other partners included USFWS, the Snake River Cutthroats TU chapter, and Mark Rockefeller.

This project was downstream of the Forest boundary. The Forest assisted due to the importance of providing Yellowstone cutthroat trout passage upstream to the Forest and improving watershed condition for all owners. This project is one component of an overall goal to restore passage and eliminate fish entrainment on Rainey Creek so it can once again be one of the major spawning tributaries to the South Fork Snake River. The project focused on elevating the stream bed below a downcut Caboose Culvert outlet. In addition, three grade control rock structures were installed to ensure channel stability below the culvert. Wood revetment and bank shaping were performed to promote channel complexity and flood plain function and improve bank stability downstream (Figure 23, Figure 24, Figure 25, and Figure 26).

Figure 23. Installing boulder grade control and wood revetment.

Figure 24. Looking upstream at the outlet during construction.

Figure 25. Before (left): Looking upstream at culvert outlet and drop causing fish barrier. After (right): Looking upstream at culvert with grade control backing up flow into the culvert and eliminating the fish barrier. Picture taken at a bank-full event following construction.

Figure 26. Before (left): Looking downstream of culvert outlet. After (right): Looking downstream of culvert outlet with high bank on left-hand side removed to increase flood capacity. Photo taken during a bank-full event. The whitewater downstream shows the location of two grade control structures.

Ice Cove Trail (#093): Trailer users created a new trail when the original trail became blocked with down timber. The user-created trail was located in the draw bottom and was affected by spring run-off events and permanent wet areas. The trail was reconstructed in its original location in the uplands.

North Fork Palisades Trail: The trail was relocated to avoid wetland, stream, and landslide crossings (Figure 27). Additional water drainage features were installed to reduce erosion. The trail originally crossed the stream then passed through approximately 100 yards of wetland. This crossing was eliminated.

Figure 27. North Fork Palisades Trail.

East Fork Trail (#160): The trail was reconstructed in 2008. In 2009, the Forest reduced impacts to several wet areas along the trail route by bridging or rerouting the trail to avoid impacts where practicable. More bridges were installed to span boggy areas and channels. Rocks were used to support the structures (Figure 28).

Figure 28. East Fork Trail before (left) and after (right) reconstruction.

Hunts Corral Trail (#081): The Forest did heavy maintenance work on 3.7 miles of this trail. Rather than rebuilding existing bog bridges, the trail was rerouted around three boggy areas to avoid impacts.

Rainey Creek Trail Improvements: The 2009 spring flows eroded the streambank into the adjacent trail. The stream eroded more than 160 feet of streambank length and an estimated 3–4 feet of width. This narrowed the ATV trail to less than 2 feet, restricting access and user safety. At the downstream end of the eroding bank, a washout created a high risk of the trail capturing streamflow and carrying it more than 750 feet until it would re-enter at the trail stream crossing.

The Forest relocated the trail onto a bench above the existing trail and further from Rainey Creek. The relocation created approximately 680 feet of new trail and closed 160 feet of old trail in the riparian area. The old trail was closed and rehabilitated (Figure 29 and Figure 30). The project was funded with RAC funds.

Figure 29. Before trail reroute (left) and after reroute and streambank stabilization (right).


Figure 30. Before (left): Vertical eroding banks decreased water quality and user safety. After (right): Trail reroute and streambank stabilization—looking downstream.

4.1.5 2010 Projects

Little Elk Mountain: This project was a follow-up effort to improve the original project that occurred in 2002. The 2010 work consisted of seeding and grade control maintenance to further stabilize 7 gullies over approximately 40 acres. The project was funded by the RAC.

Bigholes Road and Trail Closures: This project included road and trail closures of spur routes along Bigholes Road (218) (located in both the Palisades and Teton River subbasins). Approximately 40 miles of nonsystem roads and trails were closed. The Forest road crew treated roads using heavy machinery. District Wildlife Biologist Bud Alford coordinated the closure effort. In most cases, the entire length of road or trail was obliterated (Figure 31). On a few roads and trails only sections of the route were closed. The areas left open were determined to be essential for livestock management to provide cattle access between the grazing units.


Figure 31. Before (left) and after (right) obliteration.

Fall Creek Riparian Fence: The Forest reconstructed a Fall Creek riparian exclosure, which excludes grazing on approximately 50 acres and 0.25 miles of Fall Creek. The exclosure was first implemented in 1979 to study cattle grazing impacts on the stream. Since 1979, the exclosure fence has been maintained annually and cattle have not been allowed to graze within the exclosure area. The fence was deteriorating to the point where reconstruction was necessary.

The strict management has provided land managers and grazing permittees with accurate data for comparison between grazed and nongrazed portions of Fall Creek. The project was funded by the RAC with labor from the Fall Creek basin cattle permittees and the Youth Conservation Corps.

South Fork Fall Creek Trail: The Forest partnered with IDPR, the Idaho Falls Trail Machine Association, and the RAC to relocate 0.5 miles of the South Fork Fall Creek Trail (#030). Steep sections were becoming entrenched due to motorcycle use during wet periods. Three bog bridges were constructed to avoid crossing wetland areas (Figure 32).

Figure 32. New bridge on the South Fork Fall Creek Trail.

South Bear Creek Trail: The Forest used funds from IDPR to reroute 2.5 miles of South Bear Creek Trail (#048). The purpose of this project was to improve the stream and riparian conditions by moving the trail from the riparian area to upland locations where possible (Figure 33). Recent beaver activity had compounded the trail situation, which was poorly located originally. Explosives and draft horses pulling trail plows helped the trail crew complete this project.

Figure 33. Before (left) and after (right) trail rehabilitation.

Water Canyon Trail: The Forest combined with IDPR and the Backcountry Horsemen Club to reroute 1.5 miles of Water Canyon Trail (#092) (Figure 34). The original trail was too steep and had erosion problems with no way to drain snowmelt and rainfall from the trail. The trail had become entrenched, which made travel for pack/saddle stock very difficult.

The original trail has been watered barred and blocked off. The new trail switch-backs up the hill.

Figure 34. Before (left) and after (right) trail reconstruction.

Looking Glass to Pine Creek Pass Trail (#077) and the Red Creek Bridge: The IDPR Trail Cat Program assisted in the maintenance of 2.7 miles of trail. The trail crew identified locations to construct rolling dips and worked to armor numerous stream crossings in an effort to minimize the impact of off-highway vehicle recreation. They also completed basic maintenance tasks such as widening the trail corridor to allow for ATV traffic and decommissioning user-created routes and switchback cuts, which cropped up only a year after the initial trail construction (Figure 35).

Figure 35. Trail construction.

The Red Creek Bridge was also constructed on the trail. Construction of this bridge is one of the primary accomplishments of the 2010 Teton Basin trail crew (Figure 36).

Figure 36. Red Creek Bridge Construction.

Highway 31 Culvert Borings: The Forest assisted the Idaho Transportation Department in boring three culverts under the highway.

4.2 Idaho Department of Fish and Game Projects

IDFG has installed fish weirs on critical spawning tributaries of the South Fork Snake River. IDFG has been trapping spring spawners in the four main tributaries of the South Fork Snake River since 2000. Since 2004, IDFG has made a concerted effort to remove rainbow trout and hybrids from the spawning runs. These fish are taken to the family fishing pond in Victor, while Yellowstone cutthroat trout are passed upstream. IDFG has used various types of weirs, and in average or above-average snowpack years has generally been inefficient at trapping migrating fish during peak flows, which is often the period when rainbow trout migrate upstream in these tributaries.

IDFG’s goal is to maintain cutthroat trout spawning refugia that is free of introgression risks with rainbow trout. Rob Van Kirk’s research has indicated the necessity of spawning tributary refugia for the long-term persistence of cutthroat trout in the South Fork, so IDFG looked at ways to increase trapping efficiency. IDFG found two options that effectively capture migrating trout in these tributaries regardless of flow levels: electrical barriers and combination waterfall/velocity barriers.

During fall/winter 2008–2009, IDFG modified their trap at Burns Creek into a combination waterfall and velocity barrier with an adjacent fish ladder (Figure 37). They also modified the weir on Palisades Creek into an electrical barrier (Figure 38). The next year (2009–2010) they modified the Pine Creek weir into an electrical barrier (Figure 39). Most recently (2010–2011), they finished constructing a new fish weir on Rainey Creek that is several miles closer to the mouth of the tributary than the previous weir (Figure 40). This is an electrical barrier on the USFS Swan Valley work station property and concludes their weir modification effort. IDFG currently has plans to install instream PIT tag antennas with readers on Burns Creek and Pine Creek, although this work will probably not occur until 2012 at the earliest.

Figure 37. Burns Creek fish weir.

Figure 38. Palisades Creek fish weir.

Figure 39. Pine Creek fish weir.

Figure 40. Rainey Creek fish weir.

4.3 Trout Unlimited Projects

4.3.1 2006 Accomplishments on the Rainey Creek Project

The McGrath Channel relocation project on Rainey Creek is now complete. The old channel at McGrath's was much like a ditch; very straight with little or no channel sinuosity or complexity that provided little or no fish habitat. TU relocated the channel to its historic location, taking advantage of a more fish-friendly location using existing overhead cover from large cottonwood trees that will result in cooler water temperatures, greater channel complexity, and increased channel length with more sinuosity. Special attention was given to designing the new channel to improve flow and water transport. The new channel now can overflow into an important historic wetland called Millers Slough, which will improve microinvertebrate production and waterfowl nesting. The old channel was not properly designed and resulted in silt deposition covering important spawning gravels. Along with the new channel construction, a new diversion point was created and screened to prevent entrainment, and a new water control device was installed to provide water to the McGrath Pond while keeping fish from entering the pond. The old channel has been reclaimed and will be reseeded this fall. Several willow plantings will be planted after they go dormant this fall to further revegetate the new channel.

Construction of four v-shaped rock weirs was completed to facilitate fish passage at the McGrath diversion check, eliminating the need to check the diversion. A series of step pools now provides excellent habitat conditions behind the weirs and full passage conditions are available in all water flows.

4.3.2 2007–2008 Accomplishments on the Rainey Creek Project

For 2007, TU was working to restore passage on eight diversion points that exist on Rainey Creek. Designs are in place and will be implemented in 2007. TU has already modified one diversion, and passage is restored at that particular diversion. Four upper diversions can be combined into two diversion points and the ditches can be split after the diversion point. This will result in the economic savings of two fewer screen systems for the outgoing ditches and two fewer fish ladder systems needing to be built. Designs are complete and will be implemented next year. Two remaining diversions will be modified for passage and the diversion ditches screened on those ditches. Finally, a large culvert that provides access to a devolvement on Rainey Creek is perched and is impeding upstream migration. The best economical alternative is to build a series of v-weirs below the culvert to elevate the water surface with a series of stepped pools to eliminate the water drop on the exit side of the culvert. The possibility of bolting in some internal baffles will also be investigated to further reduce stream velocity through the culvert and improve passage.

TU had fish screens custom built for the two bottom diversions. Because the screen material has to meet a certain specification criteria and will need to be fabricated, TU didn’t expect to get these installed until 2009. TU is also fabricating an aluminum Alaskan steep pass ladder system for one of the diversions and a more basic ladder system for the other; both are custom builds.

Once fish passage is fully restored, TU will work with a number of private landowners to implement offsite watering for cattle, riparian fencing and revegetation components, water efficiency measures like piping or lining ditches, and a number of bank stabilization measures to complete the overall restoration of Rainey Creek. Figure 41 through Figure 44 show pictures of channel modification and restoration on Rainey Creek.

Figure 41. Rainey Creek restoration.

Figure 42. Rainey Creek diversion.

Figure 43. Rainey Creek channel modification.

Figure 44. Rainey Creek.

5 Total Maximum Daily Load(s)

A TMDL prescribes an upper limit (or *load capacity*) on discharge of a pollutant from all sources to ensure water quality standards are met. This load capacity (LC) is represented by the following equation:

$$LC = MOS + NB + LA + WLA$$

Where:

> LC = load capacity. This value indicates how much pollutant a water body can receive over a given period without causing violations of state water quality standards.
>
> MOS = margin of safety. Because of uncertainties regarding quantification of loads and the relation of specific loads to attaining water quality standards, 40 CFR Part 130 requires a margin of safety, which is effectively a reduction in the load capacity available for allocation to pollutant sources.

NB = natural background. When present, NB may be considered part of load allocation. However, it is often considered separately because it represents a part of the load not subject to control. NB is also effectively a reduction in the load capacity available for allocation to human-made pollutant sources.

LA = the load allocation for all nonpoint sources

WLA = the wasteload allocation for all point sources

A load is a quantity of a pollutant discharged over some period of time; numerically, it is the product of concentration and flow. Due to the diverse nature of various pollutants, and the difficulty of strictly dealing with loads, federal rules allow for "other appropriate measures" to be used when necessary. These other measures must still be quantifiable and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads and allow "gross allotment" as a load allocation where available data or appropriate predictive techniques limit more accurate estimates. For certain pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads. However, due to recent federal court cases, most loads must also be expressed as daily loads.

5.1 Sediment TMDLs

To restore full support of beneficial uses that may have been impaired by excess sediment, TMDL load allocations were determined using the best available data and field verification. DEQ collected streambank stability data in 2010. Streambank erosion inventory worksheets documenting this work are provided in Appendix C.

5.1.1 Instream Water Quality Targets

Sediment load capacities necessary to meet the narrative criterion for sediment and to fully support beneficial uses are determined by streambank erosion rates. DEQ has determined that excess erosion is more significant in this subbasin from unstable streambanks than from upland erosion.

5.1.1.1 *Design Conditions*

A detailed discussion of design conditions for the Palisades Subbasin is provided in the Palisades SBA and TMDL (DEQ 2001). In summary, excess streambank erosion generally occurs during spring runoff when bank-full flow occurs. Therefore, the stability characteristics of streambanks are measured at bank-full widths to determine the rate of excess erosion above natural background levels during peak flows.

5.1.1.2 *Target Selection*

In the original Palisades TMDL approved by EPA in 2001, instream sediment targets were established at 80% streambank stability and 28% or less subsurface fine sediment (particles < 6.35 millimeters [mm]) for the total streambed particle volume (DEQ 2001). Methods for determining streambank stability from field observations are based on modified Natural Resources Conservation Service methods, Rosgen stream classification systems, and other applicable literature (Rosgen 1996; Lohrey 1989; Pfankuch 1975). The 28% subsurface fine sediment target is based on research of salmonid spawning success as it relates to particle size of spawning bed materials (Hall 1986; McNeil and Ahnell 1964; Reiser and White 1988). DEQ methods for determining bank stability are thoroughly documented in Appendix G of the Palisades SBA and TMDL (DEQ 2001) and summarized in this document in Appendix C.

5.1.1.3 *Monitoring Points*

DEQ conducted streambank erosion inventories at the locations indicated in Figure 45 through Figure 47. Locations included Hawley Gulch Creek, Table Rock Canyon Creek, Squaw Creek, Iowa Creek, Trout Creek, South Fork Indian Creek, main fork Indian Creek, lower Indian Creek, Indian Creek (located on Fall Creek Road), North Fork Pine Creek, and Black Canyon Creek.

Streambank Erosion Inventory Sites

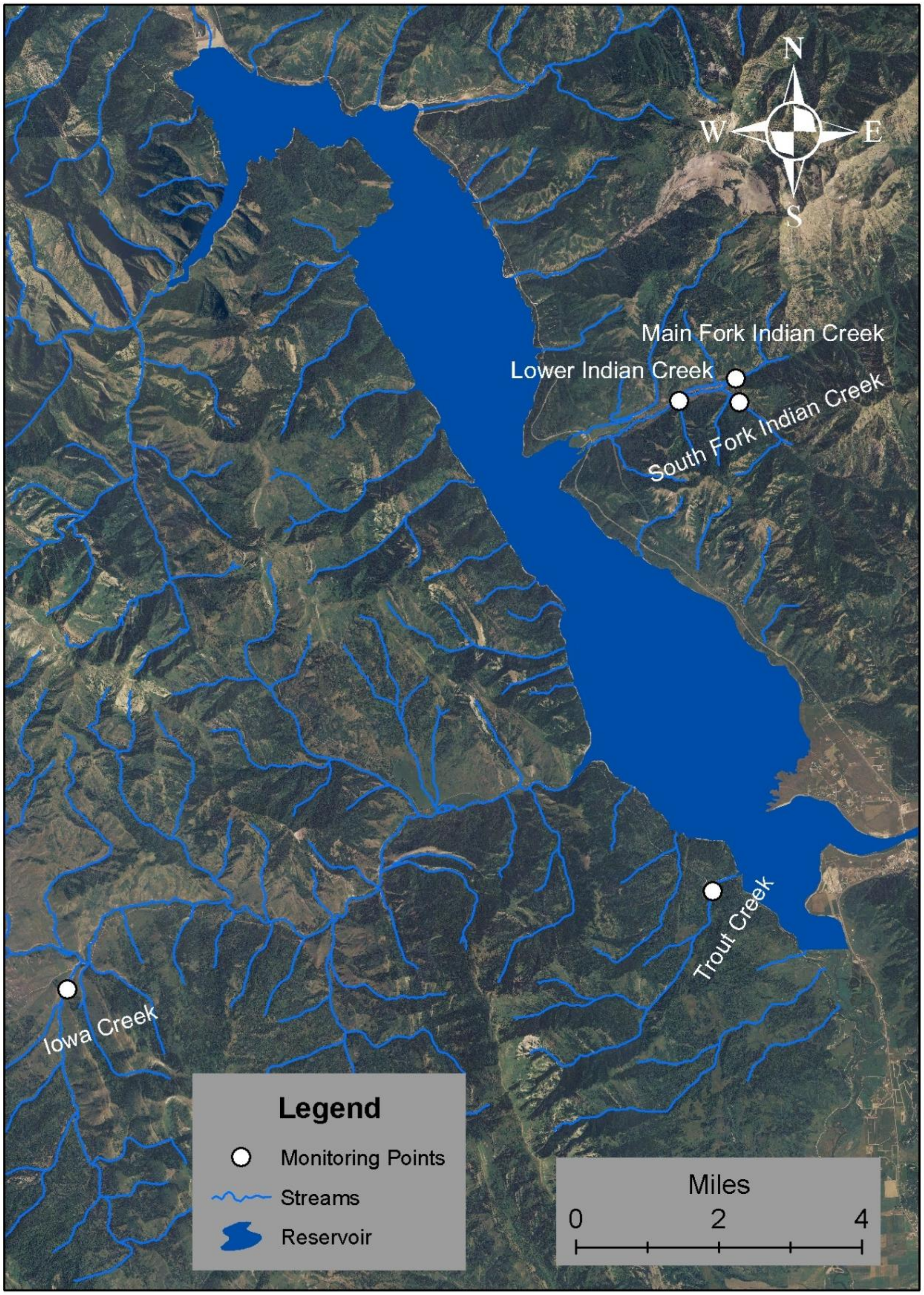

Figure 45. Sediment monitoring points on main fork Indian Creek, lower Indian Creek, South Fork Indian Creek, Trout Creek, and Iowa Creek.

Streambank Erosion Inventory Sites

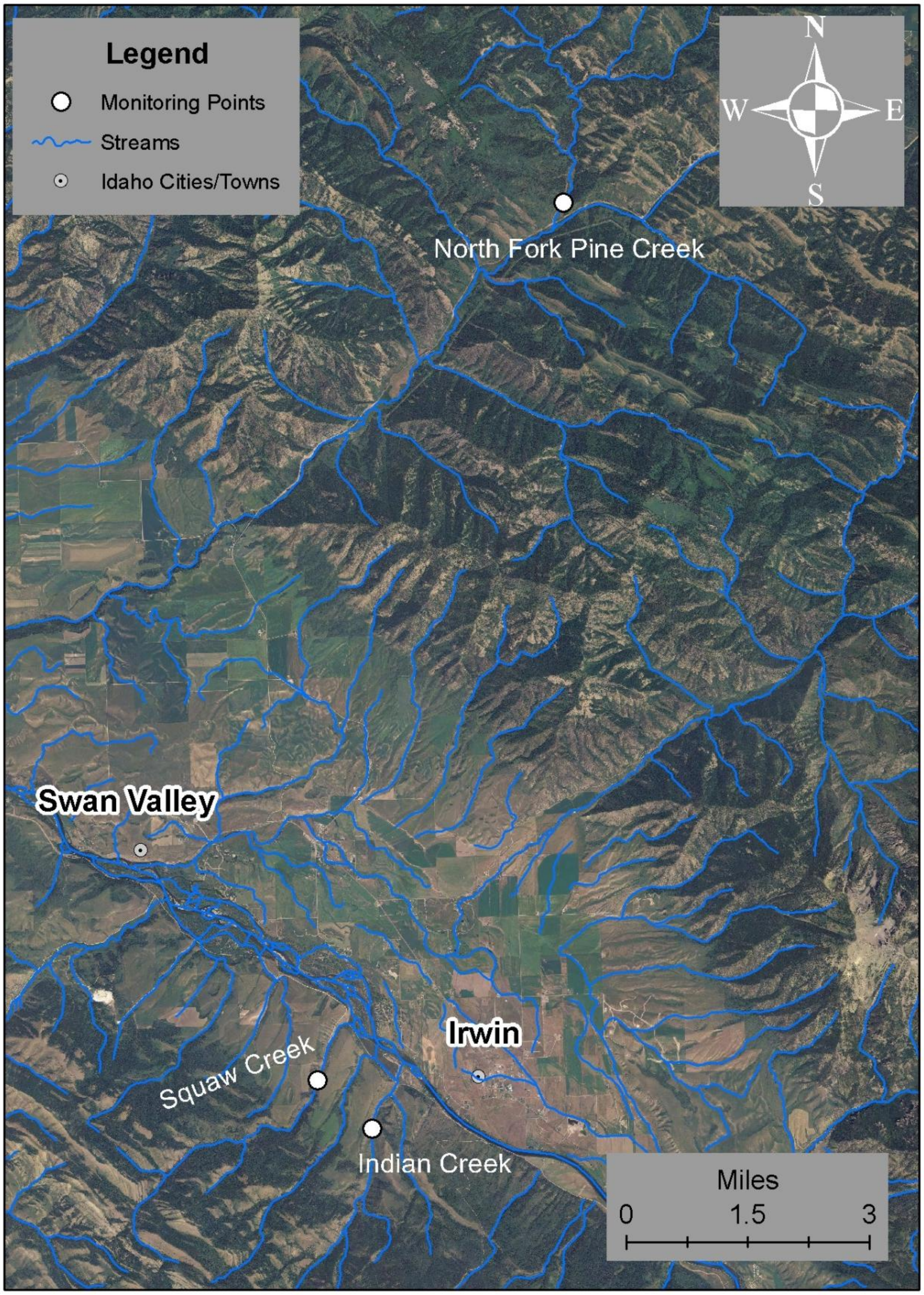

Figure 46. Sediment monitoring points on North Fork Pine Creek, Squaw Creek, and Indian Creek (Fall River Road).

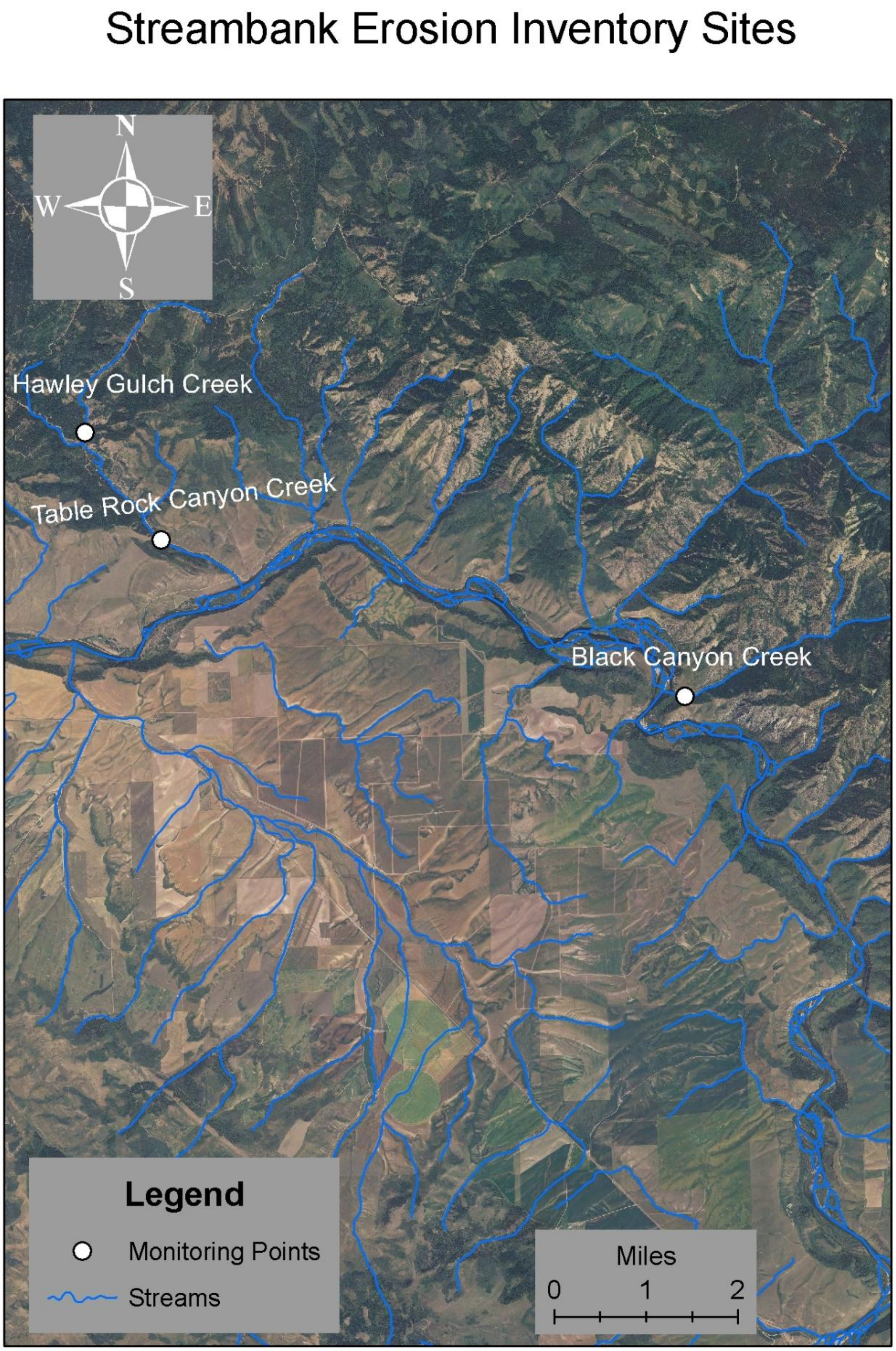

Figure 47. Sediment monitoring points on Hawley Gulch Creek, Table Rock Canyon Creek, and Black Canyon Creek.

5.1.2 Load Capacity

The sediment load capacity is the sediment loading rate at which beneficial uses are supported. The assumption is that this rate will be achieved at 80% streambank stability, but monitoring will determine the individual load capacity for each impaired reach. Progress toward the load capacity will be made by maintenance of trails and roads, land management, and improvement of riparian vegetative cover and stream channel condition. For a full discussion on load capacity, see the 2001 SBA and TMDL (DEQ 2001).

5.1.3 Estimates of Existing Pollutant Loads

Regulations allow that loadings "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading" (40 CFR 130.2(g)). The volume of eroding streambank at bank-full condition was calculated by measuring eroding bank height and length and evaluating the bank condition to estimate the lateral recession rate during periods of high streamflow, taking erodibility of the soil type into consideration. As a result of these survey results and calculations, the current loads estimated for the Palisades Subbasin are shown in Table 7.

Table 7. Current sediment loads from Hawley Gulch, Table Rock Canyon Creek, and lower Indian Creek in the Palisades Subbasin.

Load Type	Location	Current Load (tons/year)	Estimation Method
Annual sediment loading rate	Hawley Gulch Creek ID17040104SK001_02	17	Observed erosion rate calculated on target of 80% streambank stability
	Table Rock Canyon Creek ID17040104SK001_02	7	
	Lower Indian Creek ID17040104SK024_04	43	

5.1.4 Load Allocations

Sediment load allocations are estimated targets used to improve water quality until beneficial uses of cold water aquatic life and salmonid spawning are fully supported. Table 8 shows the difference between the current sediment load and the load capacity of the impaired AUs. This difference equals the necessary load reduction.

Table 8. Sediment load calculations for the Palisades Subbasin.

Water Body/ Assessment Unit	Current Load (tons/year)	Load Capacity (tons/year)	Load Reduction (tons/year)	Necessary Percent Reduction
Hawley Gulch Creek ID17040104SK001_02	17	10	7	41%
Table Rock Canyon Creek ID17040104SK001_02	7	3	4	57%
Lower Indian Creek ID17040104SK024_04	43	9	34	79%

The load capacity is the natural, minimally erosive state one would expect of a covered, stable streambank. The load capacity is the natural background condition, currently targeted to be 80% stable streambanks. The current load is the tons of sediment per year calculated for the eroding streambanks at their current condition based on field measurements. The difference between the current load and the load capacity is the necessary load reduction to move from the current condition to the natural background load capacity of the stream. The load allocation is the amount of sediment that can be discharged to the stream and still meet the water quality standards, which in this case is the same as the load capacity. Table 8 shows that the three reaches each require sediment reduction to achieve the load capacity of the AU.

The margin of safety factored into sediment load allocations includes the conservative assumptions used to develop existing sediment loads. Conservative assumptions in the sediment loading analysis are that desired bank erosion rates are representative of assumed natural background conditions. Additionally, the water quality target for subsurface fine sediment is consistent with values measured and is set by local land management agencies based on established literature values, incorporating an adequate level of fry survival to provide for stable salmonid production.

Peak streamflows of the three sediment-impaired reaches occur during spring snowmelt. The largest proportion of sediment is eroded from the streambanks during spring high flow. The daily sediment load is allocated based on flow. Flow duration intervals summarize the cumulative frequency of historic flow data over the period of record for which streamflow data have been recorded. At the lower Indian Creek reach, a real-time USGS stream gage (USGS 13030000) provides 44 years of daily streamflow data.

EPA describes an approach for using load duration curves in developing TMDLs and specifies calculating the cumulative frequency distribution using streamflow records (EPA 2007). Following this guidance, the 0–10th percentile streamflows are designated as high flows, 10th–40th percentiles as moist conditions, 40th–60th as mid-range flows, 60th–90th percentiles as dry conditions, and 90th–100th represent low flows. This approach places the midpoints of the moist, mid-range, and dry zones at the 25th, 50th, and 75th quartiles, respectively (Figure 48).

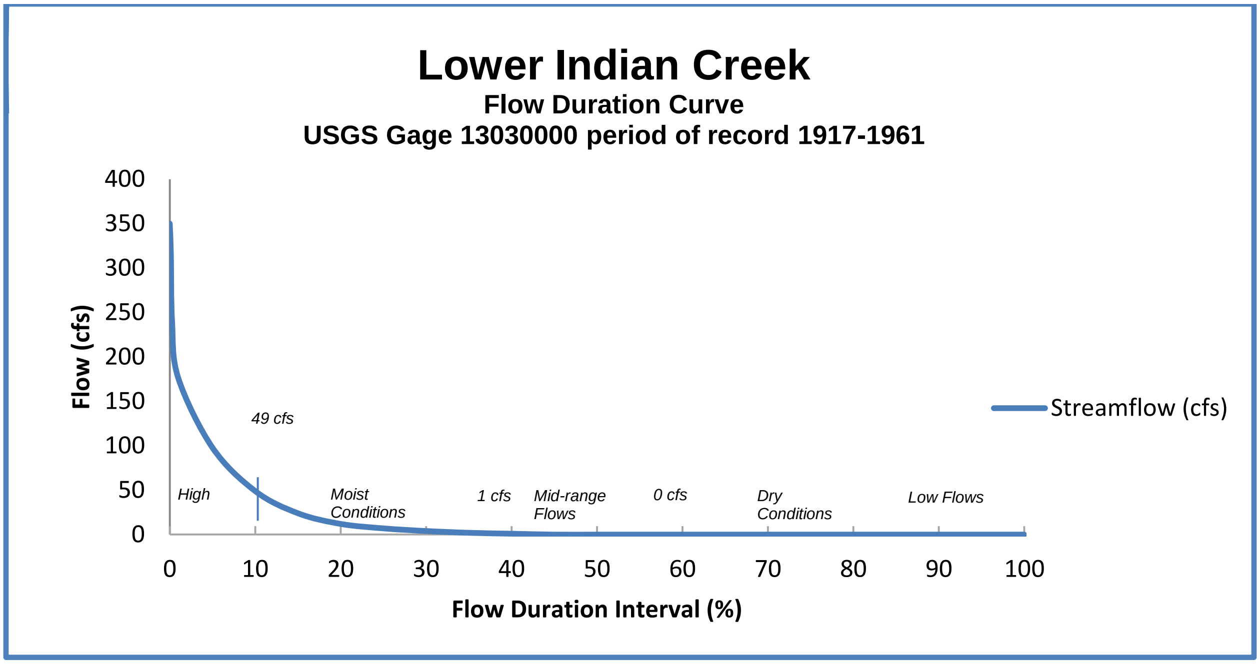

Figure 48. Flow duration curve for lower Indian Creek at USGS 13030000.

The flow duration intervals of all daily streamflow data during the period of record are as follows:

- High flow (0—10th percentile) occur at 49–350 cfs.
- Moist conditions (10th–40th percentile) occur at 1–48 cfs.
- Low flow (40th–100th percentile) occur at 0–1 cfs.

To find the average yearly dates those flows exist in lower Indian Creek, one can examine the USGS daily water statistics that show the mean of daily mean values over the period of record. For USGS gage 13030000, the daily water statistics are shown in Table 9.

Table 9. Mean of daily mean streamflows for lower Indian Creek at USGS gage 13030000.

USGS Daily Water Statistics, 13030000, AU ID17040104SK024_04												
Day of	Mean of daily mean values for each day for period of record in cfs											
month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	0	0	0	2.8	83	61	9.3	2.4	0.71	0.38	0
2	0	0	0	0	2.8	87	58	10	2.4	0.55	0.25	0
3	0	0	0	0	2.8	93	55	7.1	2.2	0.54	0.25	0
4	0	0	0	0	3.5	94	51	6	2.1	0.53	0.25	0
5	0	0	0	0	4.3	103	47	5.3	2	0.5	0	0
6	0	0	0	0.12	5.1	112	45	4.4	1.9	0.51	0	0
7	0	0	0	0.38	9.4	117	42	4.4	1.9	0.5	0	0
8	0	0	0	0.75	9.9	120	37	5.2	1.9	0.53	0	0
9	0	0	0	1	13	130	34	4.7	1.8	0.56	0.12	0
10	0	0	0	1.2	17	130	33	5	1.9	0.55	0.12	0
11	0	0	0	1.1	22	131	31	3.6	1.8	0.42	0.25	0
12	0	0	0	1	23	136	29	3.3	1.7	0.66	0.25	0
13	0	0	0	0.88	24	140	28	3.3	1.6	0.51	0.12	0
14	0	0	0	0.75	23	142	35	3.6	1.6	0.51	0.12	0
15	0	0	0	0.62	23	135	33	3	1.6	0.53	0.75	0
16	0	0	0	0.5	26	104	31	3.1	1.6	0.53	0.5	0
17	0	0	0	0.38	30	96	29	2.9	1.5	0.51	0.12	0
18	0	0	0	0.38	34	91	27	2.7	1.9	0.38	0.12	0
19	0	0	0	0.5	41	89	26	3	1.5	0.38	0.12	0
20	0	0	0	0.75	46	92	25	3.4	1.3	0.25	0.25	0
21	0	0	0	1.1	53	96	23	3.2	1.3	0.25	0.38	0
22	0	0	0	1.5	59	91	21	3.3	1.3	0.38	0.38	0
23	0	0	0	2.1	65	90	20	3.3	1.2	0.62	0.38	0
24	0	0	0	2	65	92	18	4.3	1.2	0.38	0.38	0
25	0	0	0	1.9	67	83	16	4.1	1.3	0.38	0	0
26	0	0	0	3.5	68	78	16	3.7	1.2	0.5	0.12	0
27	0	0	0	5.1	70	74	14	2.8	1.1	0.5	0	0
28	0	0	0	4.1	70	72	13	2.6	1.1	0.38	0	0
29	0	0	0	5	74	71	12	2.5	1	0.38	0.12	0
30	0		0	3.5	73	67	11	2.3	1	0.38	0.12	0
31	0		0		78		10	2.3		0.38		0
	0	0	0	1.337	35.63226	101.3	30.03226	4.119355	1.61	0.473871	0.195	0

High Flows 0 to 10 % 49 cfs to 350 cfs Occur from May 21st to July 4th

Moist Condtions 10 to 40% 1cfs to 48 cfs Occur April 21st to May 20th and July 5th to September 30th

Mid-range flows, Dry conditions and Low flows 40 to 100% 0 cfs to 1 cfs Occur October 1st to April 20th

For the flows indicated in the flow duration curve, DEQ highlighted the daily water statistics for each level of flow for easier readability. Bank-full flows in lower Indian Creek (AU ID17040104SK024_04) occur only during high flows. Therefore, 85% of the sediment load delivery occurs during high flows and 15% occurs during flow regimes that EPA guidance designated as moist conditions, mid-range, dry, and low flows (EPA 2007). The annual load allocation for this AU is 34 tons per year. Table 10 shows the flow-weighted daily load allocations with proportionality assumptions based on flow season.

Therefore, for a typical year, the following are the daily sediment load allocations for lower Indian Creek:

- 1,209 pounds per day May 21–July 4
- 86 pounds per day April 21–May 20 and July 5–September 30
- 17 pounds per day October 1–April 20

Table 10. Flow-weighted daily sediment load allocation for lower Indian Creek, assessment unit (AU) ID17040104SK024_04, with proportionality assumptions based on flow season.

	Total Annual Load Allocation = 34 tons per year		
	85% Load Delivery	**15% Load Delivery**	
Seasonal streamflow averages	High flows 49–350 cfs	Moist conditions 1–48 cfs	Low flows 0–1 cfs
Seasonal load allocation	27.2 tons/year reduction	5.10 tons/year reduction	1.70 tons/year reduction
Average dates from USGS daily water statistics	May 21–July 4	April 21–May 20 July 5–September 30	October 1–April 20
Days in flow season	45	118	202
Daily load allocation	1,209.0 lb/day reduction	86.0 lb/day reduction	17.0 lb/day reduction

The Hawley Gulch Creek reach with a sediment load allocation does not have a real-time stream gage. Flows were derived from historical flow data based on USGS StreamStats predicted streamflow. The flow duration curve for Hawley Gulch Creek is shown in Figure 49.

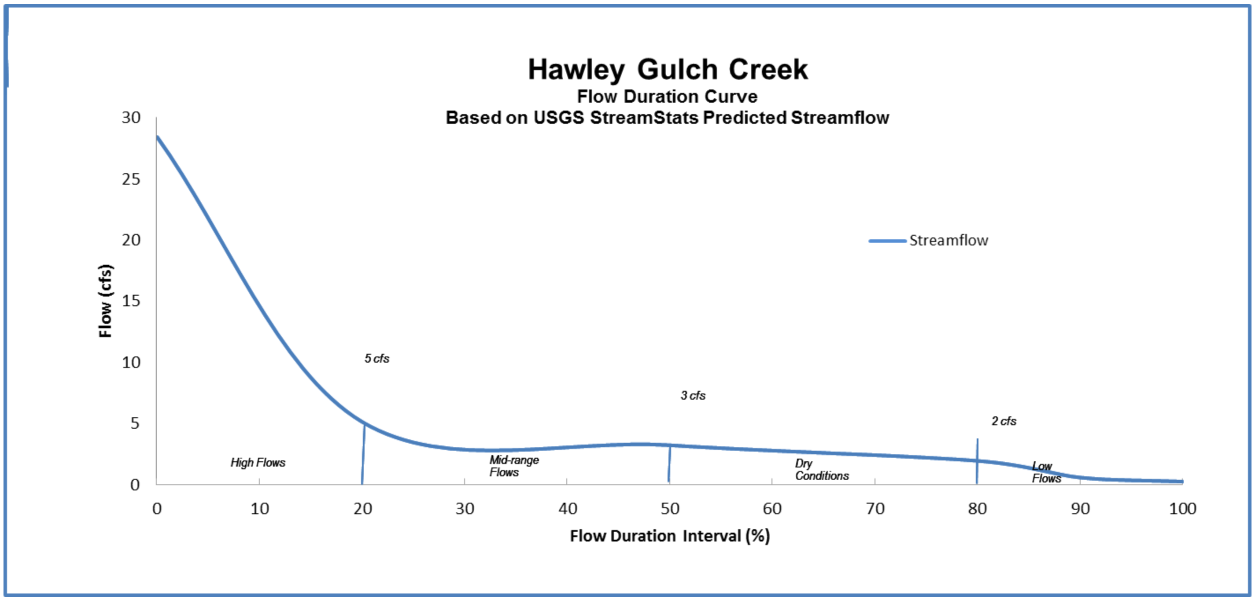

Figure 49. Flow duration curve for Hawley Gulch Creek based on USGS StreamStats predicted streamflow.

The following are the flow duration intervals for the high and low flows according to USGS StreamStats:

- High flows (0–10th percentile) occur at 15–28 cfs.
- Low flows (10th–100th percentile) occur at 0–15 cfs.

Bank-full flows for Hawley Gulch Creek (AU ID17040104SK001_02) occur only during high flows. Therefore, 85% of the sediment load delivery occurs during high flows, and 15% occurs during low-flow conditions. The annual load allocation for this AU is 7 tons per year. Table 11 shows the flow-weighted daily load allocations with proportionality assumptions based on flow season.

Therefore, for a typical year, the daily sediment load allocations for Hawley Gulch Creek are as follows:

- 195 pounds per day for 61 days during April and May.
- 6.9 pounds per day for 304 days during June–March.

Table 11. Flow-weighted daily sediment load allocation for Hawley Gulch Creek, assessment unit (AU) ID17040104SK001_02, with proportionality assumptions based on flow season.

	Total Annual Load Allocation = 7 tons per year	
	85% Load Delivery	**15% Load Delivery**
Seasonal streamflow averages	High flows 5–28 cfs	Low flows 0–5 cfs
Seasonal load allocation	5.95 tons/year reduction	1.05 tons/year reduction
Average dates from USGS daily water statistics	April and May	June–March
Days in flow season	61	304
Daily load allocation	195.0 lb/day reduction	6.9 lb/day reduction

The Table Rock Canyon Creek reach with a sediment load allocation does not have a real-time stream gage. Flows were derived from historic flow data based on USGS StreamStats predicted streamflow. The flow duration curve for Hawley Gulch Creek is shown in Figure 50.

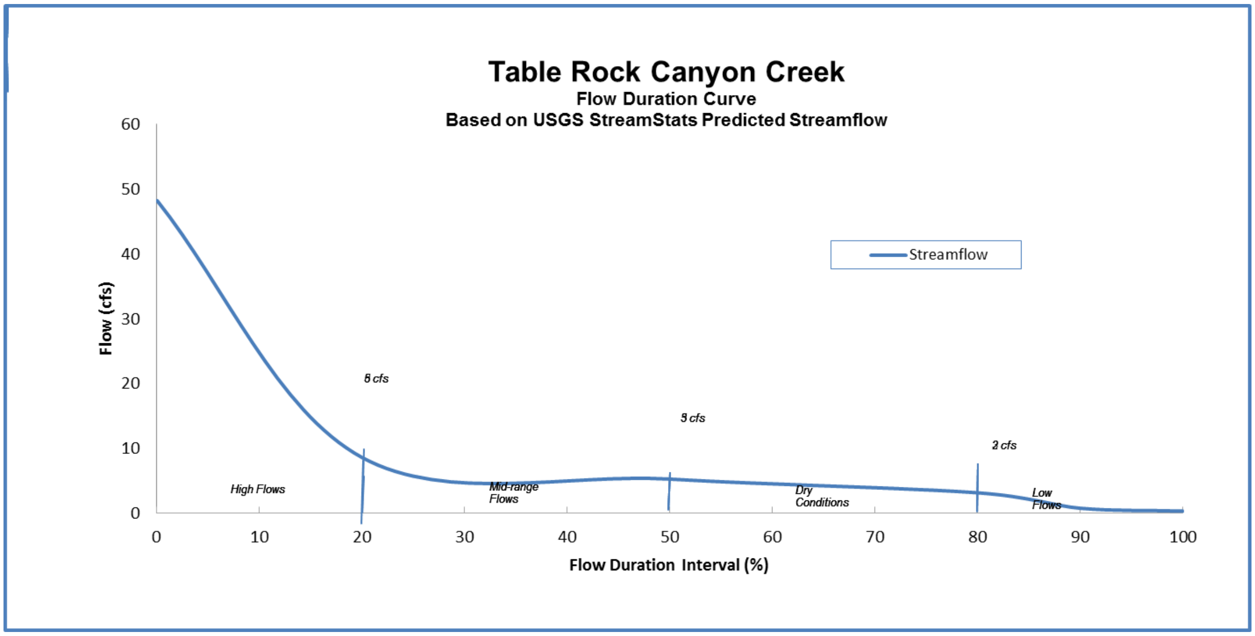

Figure 50. Flow duration curve for Table Rock Canyon Creek based on USGS StreamStats predicted streamflow.

The following are the flow duration intervals for the high and low flows according to USGS StreamStats:

- High flows (0–10th percentile) occur at 25–48 cfs.
- Low flows (10th–100th percentile) occur at 0–25cfs.

Bank-full flows for Table Rock Canyon Creek (AU ID17040104SK001_02) occur only during high flows. Therefore, 85% of the sediment load delivery occurs during high flows, and 15% occurs during low-flow conditions. The annual load allocation for this AU is 4 tons per year. Table 12 shows the flow-weighted daily load allocations with proportionality assumptions based on flow season.

Therefore, for a typical year, the daily sediment load allocations for the Table Rock Canyon Creek are as follows:

- 96 pounds per day for 61 days during April and May.
- 6.9 pounds per day for 304 days during June–March.

Table 12. Flow-weighted daily sediment load allocation for Table Rock Canyon Creek, assessment unit (AU) ID17040104SK001_02, with proportionality assumptions based on flow season.

	Total Annual Load Allocation = 4 tons per year	
	85% Load Delivery	**15% Load Delivery**
Seasonal streamflow averages	High flows 8–48 cfs	Low flows 0–5 cfs
Seasonal load allocation	2.95 tons/year reduction	1.05 tons/year reduction
Average dates from USGS daily water statistics	April and May	June–March
Days in flow season	61	304
Daily load allocation	96.0 lb/day reduction	6.9 lb/day reduction

Although the sediment load allocations are expressed in terms of daily reductions, progress toward meeting the natural background load capacity is measured through the surrogate targets of 80% streambank stability and 28% subsurface fine sediment.

5.1.4.1 *Margin of Safety*

Conservative assumptions used to develop existing sediment loads ensure a margin of safety. These conservative assumptions include the following:

- Evaluating desired bank erosion rates as natural background conditions
- Using a target of subsurface fine particles based on literature values that supports fry survival providing for a stable salmonid population

5.1.4.2 *Seasonal Variation*

Streambank erosion inventories take seasonal variation into account by deriving average annual loading rates based on runoff events and peak and base streamflow conditions. It is assumed that most or all of the lateral recession occurs during peak-flow events. Therefore, bank conditions at bank-full level are measured and evaluated in the field to calculate current rates of erosion and sediment delivery.

5.1.4.3 *Natural Background*

Natural background loading rates are assumed to be the sediment load capacity of the TMDL calculation. Natural background conditions are presumed to be met at 80% streambank stability and 28% or less subsurface fine sediment.

5.2 Bacteria TMDL

One AU is listed for *E. coli* on the 2010 IR: Rainey Creek—source to mouth, ID17040104SK028_04. This AU is designated for the recreational use of secondary contact recreation. As a result, bacteria targets shall not exceed the single instantaneous measure of 576 colonies/100 mL and the geometric mean of 126 colonies/100 mL for 5 samples collected in a 30-day period every 3 to 7 days.

This AU was first listed in 2002 for pathogens in Rainey Creek. This listing was based on *E. coli* results at the 1998SIDFC008 BURP site of a geometric mean of 200 colonies/100 mL. Results of this bacteria monitoring in AU ID17040104SK028_04 are shown in Table 6.

5.2.1 Instream Water Quality Targets

Instream water quality targets for AU ID17040104SK028_04 in the Rainey Creek watershed were set from the Idaho water quality standards. The water quality standards relate beneficial use impairment to a numeric standard (e.g., "...Waters designated for recreation are not to contain *E. coli* bacteria…" IDAPA 58.01.02.251.01). The target developed for bacteria impairment is the *E. coli* water quality standard.

5.2.1.1 Design Conditions

Bacteria affect the creek throughout the summer months and into the fall during baseflow conditions. The critical period for recreational beneficial use is from May through October. With no known sources of human-caused bacteria loading, it is assumed that the observed *E. coli* levels are caused by a combination of wildlife, waterfowl, and livestock. To protect the beneficial use, the design conditions should fall within the critical period when the bacteria contamination is most likely to occur.

5.2.1.1.1 Streamflow

Daily statistics for historic streamflow recorded at USGS stream gage 13034500 on Rainey Creek is shown in Table 13. These values represent the mean streamflow for the daily mean values for April through October at Rainey Creek.

Table 13. Mean of daily mean values for Rainey Creek streamflow measured April through October during the period of record at USGS 13034500.

Day of	Mean of daily mean values for each day for 2 - 5 years of record in, ft3/s (Calculation Period 1916-10-01 -> 1937-09-30)											
month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1				23	90	115	57	62	48	34		
2				23	88	112	56	60	47	35		
3				23	87	111	55	58	48	35		
4				23	122	103	55	65	47	35		
5				23	128	102	53	64	47	36		
6				23	130	101	52	60	50	34		
7				23	106	102	52	63	52	34		
8				23	92	105	51	56	52	34		
9				25	101	105	52	53	52	35		
10				26	136	103	52	52	51	35		
11				29	150	102	52	49	50	36		
12				35	148	100	53	49	48	36		
13				40	153	96	52	48	47	36		
14				49	158	96	51	55	47	36		
15				56	144	93	52	56	47	37		
16				59	137	90	52	54	47	38		
17				69	131	87	53	54	46	39		
18				74	132	83	52	50	45	40		
19				76	127	81	53	46	46	41		
20				81	112	78	53	47	46	42		
21				102	109	75	51	47	46	41		
22				115	114	66	51	47	46	41		
23				121	121	83	51	45	46	43		
24				124	130	79	51	46	46	43		
25				101	132	74	51	47	46	43		
26				95	128	66	50	48	46	43		
27				96	108	62	50	48	44	43		
28				97	98	59	53	50	43	41		
29				99	91	58	56	50	43	41		
30				133	88	60	55	49	43	41		
31					83		56	49		41		

In order to characterize the bacteria load using the critical period, DEQ uses the lowest daily mean streamflow value from the analysis of the daily water statistics from USGS gage 13034500. Critical low flow equals 23 cfs and occurs in early April, as shown in Table 13.

5.2.1.1.2 Monitoring Points

AU ID17040104SK028_04 should be monitored for compliance with the *E. coli* bacteria secondary contact recreation criteria at the BURP locations where exceedances originally occurred:

- Rainey Creek—1998SIDFC008; 43.448°N, -111.333°W.

5.2.2 Load Capacity

In bacteria TMDLs, the water quality standard is the load capacity of a system. By using a percentage of the target or "load capacity," the calculations become unitless percentages, which overcome the inherent problem of calculating loads from a parameter that does not lend itself to load calculations. Allocations can then be made from this percentage of the load and must be met at all times. Grazing accounts for 80% of the load allocation. The remaining 20% will be distributed between the margin of safety (10%) and the wildlife (natural background) component (10%).

The load capacity is based on the critical low flow of 23 cfs, which occurs in early April, according to historic streamflow records at Rainey Creek shown above in Table 13. The bacteria TMDL is calculated as a function of 126 cfs/100 mL as the target and 23 cfs as the flow according to the following calculation:

$$\text{E. coli TMDL} = \frac{126\ cfu \times\ 23\ cf \times 86400\ seconds \times 1\ mL}{100\ mL \times 1\ second \times 1\ day \times .000353\ cf} = 7{,}093{,}121{,}813\ \text{cfu/day, or } 7.1\ \text{cfu}^9\text{/day}$$

Where:
126 cfu/100 mL is the E. coli target
23 cfs is the critical low flow
864000 seconds per day is the time conversion
1 mL per 0.000353 cubic feet is the volume conversion

Therefore, 7.1 cfu^9/day is the load capacity for Rainey Creek.

5.2.3 Estimates of Existing Pollutant Loads

For future monitoring, natural background will be estimated from bacteria data collected during the noncritical period (April through May and October through November). The nonpoint source load will be the difference in the previous number and average bacteria counts collected during the critical period for recreation (May through October).

Historic monitoring in 1999 resulted in *E. coli* geometric mean exceedances in Rainey Creek (200 colonies/100 mL). This bacteria TMDL is based on those measurements (Appendix D).

Grazing by domestic cattle historically occurred in the uplands and lowlands of the Rainey Creek watershed. However, modern range management has limited grazing in this AU.

5.2.4 Load Allocations

Even though potential sources and pathways of bacteria are limited, DEQ is allocating a load reduction for *E. coli* based on historic data so that ongoing monitoring will occur in this AU. The *E. coli* results are presented in Table 14 and the load allocation is presented in Table 15.

Table 14. E. Coli monitoring results for Rainey Creek

Date	E. Coli (cfu) @ RaineyCreek Creek
8/12/99	470
8/16/99	100
8/19/99	780
8/23/99	80
8/26/99	110
Geometric Mean	**200**

Table 15. Bacteria load allocation for Rainey Creek (geometric mean of number of colonies per 100 milliliter sample).

Stream	Load Capacity	Natural Background	Margin of Safety	Load Allocation	Total Load	Load Reduction	Percent Reduction
			cfu/100 mL				%
Rainey Creek	126	13	13	100	200	100	50%
cfu^9/day*	7.1	0.7	0.7	5.6	11.3	5.6	
*TMDL expressed as billion colony forming units per day							

To support the beneficial use of secondary contact recreation, the number of *E. coli* colonies must not exceed either a single instantaneous sample of 576 colonies/100 mL or a geometric mean of 126 colonies/100 mL for 5 samples collected in a 30-day period 3 to 7 days apart. Since this target is not seasonal, it is applied as a daily load allocation.

5.2.4.1 *Margin of Safety*

For the Rainey Creek bacteria TMDL, an explicit margin of safety is set at 10%, and an additional 10% is allocated to the natural background bacterial population contributed by wildlife. In addition, any conservative approaches used in the various calculations required by a TMDL will be included as an implicit component of the MOS.

5.2.4.2 *Seasonal Variation*

In Rainey Creek, the summer growing season is when concentrations of bacteria are the highest. This season is also when water flow is lowest. With lower water flow, bacteria increase due to a combination of agricultural diversion and return flow. Seasonal variation as it relates to development of this TMDL is addressed by ensuring that loads are reduced during the critical period (when beneficial uses are impaired and loads are controllable). Thus, the effects of seasonal variation are built into the load allocations.

5.2.4.3 *Wasteload Allocation*

There are no point sources within the Rainey Creek watershed, so no wasteload allocation is established.

5.2.4.4 *Reasonable Assurance*

After TMDL acceptance by DEQ, EPA, and stakeholders, the next step of the Idaho water body management process is implementation. Idaho's water quality standards identify designated agencies that are responsible for evaluating and modifying BMPs to protect impaired water bodies. DEQ is committed to developing implementation plans within 18 months of EPA approval of a TMDL document. The applicable WAG, DEQ, and other agencies will develop implementation plans, and DEQ will incorporate them into the state's water quality management plan.

Ongoing assessment of the support status of the water bodies with TMDLs will be reported in a 5-year review of the TMDL. If full support status has not been achieved, further implementation will be necessary and further reassessment performed until full support status is reached. Monitoring will be done at least every 5 years. If full support status is reached, the requirements of the TMDL will be considered complete.

5.3 Construction Stormwater Requirements

The CWA requires operators of construction sites to obtain permit coverage to discharge stormwater to a water body or municipal storm sewer. In the past, stormwater was treated as a nonpoint source of pollutants. However, because stormwater can be managed on site through management practices or when discharged through a discrete conveyance such as a storm sewer, it now requires an NPDES permit.

In Idaho, EPA has issued a general permit for stormwater discharges from construction sites. If a construction project disturbs more than 1 acre of land (or is part of a larger common development that will disturb more than 1 acre), the operator is required to apply for Construction General Permit (CGP) from EPA after developing a site-specific stormwater pollution prevention plan (SWPPP). Operators must develop a site-specific SWPPP. Operators must document the erosion, sediment, and pollution controls they intend to use; inspect the controls periodically; and maintain BMPs throughout the life of the project.

When a stream is on Idaho's §303(d) list and has a TMDL developed, DEQ may incorporate a gross wasteload allocation for anticipated construction stormwater activities. TMDLs developed in the past that did not have a wasteload allocation for construction stormwater activities will also be considered in compliance with provisions of the TMDL if they obtain a CGP under the NPDES program and implement the appropriate BMPs. The permit holder is expected to abide by the conditions of the CGP and conduct any required monitoring as spelled out in the permit.

Typically, operators must follow specific requirements to be consistent with any local pollutant allocations. Many communities throughout Idaho are currently developing rules for postconstruction stormwater management. Sediment is usually the main pollutant of concern in stormwater from construction sites. Applying specific BMPs from Idaho's *Catalog of Stormwater Best Management Practices for Idaho Cities and Counties* is generally sufficient to meet the standards and requirements of the CGP, unless local ordinances have more stringent and site-specific standards that are applicable (DEQ 2005).

5.4 Public Participation

DEQ provided the South Fork Snake WAG with all available information pertinent to the SBA/TMDL, when requested, such as monitoring data, water quality assessments, and relevant reports. The WAG had the opportunity to actively participate in preparing the SBA/TMDL documents. WAG meetings occurred on the following dates:

- February 17, 2010—Preliminary discussion with the South Fork Snake WAG about the upcoming TMDL and five-year review.
- March 16, 2011—Discussed ongoing issues with the South Fork Snake WAG and addressed concerns with the TMDL and 5-year review. At this meeting, the WAG

provided their support to complete the draft document and proceed to public comment upon its completion.

The following steps have been conducted for this public involvement process:

1. Solicited the local offices of the Idaho Soil and Water Conservation Commission, USFS, IDFG, and Bureau of Land Management for information to include in the document
2. Held a South Fork Snake WAG meeting on March 16, 2011, to address any questions or concerns
3. Notified Bureau of Land Management and USFS local offices and EPA of the document's contents and pending public comment period
4. Published the draft document for the public comment period from May1, 2013, through May 30, 2013, on the DEQ website
5. Advertised the public comment period in the Idaho Falls *Post Register* and the Jefferson County *Jefferson Star*.

A distribution list is provided in Appendix E. A summary of public comments received during the public comment period and DEQ's responses can be found in Appendix F.

5.5 Implementation Strategies

Implementation strategies for TMDLs may need to be modified if monitoring shows that TMDL goals are not being met or significant progress is not being made toward achieving the goals. Twenty years are allotted for meeting the sediment allocations after implementation strategies have been in place. This time frame should allow for two or three channel-forming events to occur and for riparian vegetation to stabilize the banks.

5.5.1 Approach, Monitoring Strategy, and Responsible Parties

The designated management agencies, WAG, DEQ, and other appropriate participants will plan BMPs specific to each impaired reach with a load allocation. The plan will include measureable milestones and a timeline for implementation. A monitoring plan conducted with DEQ-approved methods will be implemented that measures progress toward meeting Idaho's water quality standards. The public will also have an opportunity to be involved with implementation planning.

6 Conclusions

Significant watershed improvements have been made since the initial pollutant analyses and load allocations were made in the Palisades SBA and TMDL (DEQ 2001). Lead agencies such as the IDFG and USFS along with TU have established several key projects in the subbasin. Projects include stream restoration, fencing, trail and road rehabilitation, fish weirs, and culvert replacement. Practices dictated by the latest scientific knowledge and technology are being implemented and will lead to a reduction in excess sedimentation that may currently be impairing beneficial uses such as salmonid spawning and recreational uses.

This TMDL analysis investigated 10 AUs listed in Idaho's 2010 Integrated Report for various pollutant impairments (DEQ 2011). Recommendations for changes in listing status are provided in in Table 16. Summary of assessment outcomes for waters listed in the 2010 Integrated Report (DEQ 2011).

Water Body Segment/ Assessment Unit	Listed Pollutant(s)	TMDL Completed	Recommended Changes to Next Integrated Report	Justification
Snake River—Black Canyon Creek to river mile 856 ID17040104SK001_02	Combined Biota/Habitat Bioassessments	Yes	Delist for Combined Biota/Habitat Bioassessments. List in Category 4a for Sediment.	Excess sediment causing impairment. Sediment load allocation developed.
Snake River—Palisades Reservoir Dam to Fall Creek ID17040104SK008_02	Combined Biota/Habitat Bioassessments; sedimentation/Siltation	No	Retain in Category 5 for Combined Biota/Habitat Bioassessments and Sedimentation/Siltation. .	Meets water quality targets. No pollutant pathways or sources of impairment found. Forested/recreation lands. BURP or other biological metric will be conducted to determine if beneficial uses are now fully supported.
Bear Creek—North Fork Bear Creek to Palisades Reservoir ID17040104SK011_02	Combined Biota/Habitat Bioassessments	No	Delist for Combined Biota/Habitat Bioassessments. Keep listed in Category 4a for Sediment.	Sediment was found to be the pollutant and sediment TMDL was approved by EPA in 2001.
Bear Creek—source to North Fork Bear Creek ID17040104SK013_03	Combined Biota/Habitat Bioassessments	No	Delist for Combined Biota/Habitat Bioassessments. Keep listed in Category 4a for Sediment.	Sediment was found to be the pollutant and sediment TMDL was approved by EPA in 2001.
Iowa Creek—source to mouth ID17040104SK020_03	Combined Biota/Habitat Bioassessments; Habitat Assessment (streams); Cause Unknown	No	Delist for Combined Biota/Habitat Bioassessments, Habitat assessment (streams), and Cause Unknown. Move to Category 2.	Meets water quality targets; no pollutant pathways or sources of impairment found. Appears to be listing error based on ADB BURP info
Trout Creek—source to mouth ID17040104SK022_02	Sedimentation/Siltation	No	Delist for Sedimentation/ Siltation. Move to Category 2.	Meets water quality targets. No pollutant pathways or sources of impairment found. Forested/recreation lands. Listing error due to miscalculation of SFI BURP metric.
Indian Creek—Idaho/Wyoming border to Palisades Reservoir ID17040104SK024_04	Combined Biota/Habitat Bioassessments	Yes	Delist for Combined Biota/Habitat Bioassessments. Move to Category 4a.	Sediment determined to be the impairment; sediment load allocation developed.

Water Body Segment/ Assessment Unit	Listed Pollutant(s)	TMDL Completed	Recommended Changes to Next Integrated Report	Justification
Rainey Creek—source to mouth ID17040104SK028_04	Combined Biota/Habitat Bioassessments; Escherichia coli	Yes	List in Category 4a for *E. coli*.	Maintain Combined Biota/Habitat Bioassessments listing until further analysis can be completed.or BURP confirms beneficial use support. *E. coli* TMDL completed.
Pine Creek—source to mouth ID17040104SK029_03	Cause Unknown	No	Delist for Cause Unknown. Change to Combined Biota/Habitat Bioassessments and retain in Category 5	Meets water quality targets; no pollutant pathways or sources of impairment found. Forested/recreation lands. BURP will be conducted to determine if beneficial uses are now fully supported or other biological stressor analysis. Little to no site access and BURP not conducted in multiple years.
Black Canyon Creek—source to mouth ID17040104SK030_02	Sedimentation/Siltation	No	Delist for Sedimentation/Siltation. Move to Category 2	Meets sediment water quality targets. No pollutant pathways or sources of impairment found. Forested/recreation lands. Passed BURP in 2001 .

. Sediment load allocations were developed for two AUs in the Palisades Subbasin and 1 AU for bacteria. Most of the major gaps between existing pollutant loads and targets are along tributaries of the South Fork Snake River; land managers may focus their efforts here to see the best return for their efforts. The largest percent reduction in sediment load is required in lower Indian Creek (ID17040104SK024_04) at 79%, followed by Table Rock Canyon Creek (ID17040104SK001_02) at 57% and Hawley Gulch Creek (ID17040104SK001_02) at 41%. Table 16 summarizes the sediment load analysis.

Table 16. Summary of assessment outcomes for waters listed in the 2010 Integrated Report (DEQ 2011).

Water Body Segment/ Assessment Unit	Listed Pollutant(s)	TMDL Completed	Recommended Changes to Next Integrated Report	Justification
Snake River—Black Canyon Creek to river mile 856 ID17040104SK001_02	Combined Biota/Habitat Bioassessments	Yes	Delist for Combined Biota/Habitat Bioassessments. List in Category 4a for Sediment.	Excess sediment causing impairment. Sediment load allocation developed.
Snake River—Palisades Reservoir Dam to Fall Creek ID17040104SK008_02	Combined Biota/Habitat Bioassessments; sedimentation/Siltation	No	Retain in Category 5 for Combined Biota/Habitat Bioassessments and Sedimentation/Siltation. .	Meets water quality targets. No pollutant pathways or sources of impairment found. Forested/recreation lands. BURP or other biological metric will be conducted to determine if beneficial uses are now fully supported.
Bear Creek—North Fork Bear Creek to Palisades Reservoir ID17040104SK011_02	Combined Biota/Habitat Bioassessments	No	Delist for Combined Biota/Habitat Bioassessments. Keep listed in Category 4a for Sediment.	Sediment was found to be the pollutant and sediment TMDL was approved by EPA in 2001.
Bear Creek—source to North Fork Bear Creek ID17040104SK013_03	Combined Biota/Habitat Bioassessments	No	Delist for Combined Biota/Habitat Bioassessments. Keep listed in Category 4a for Sediment.	Sediment was found to be the pollutant and sediment TMDL was approved by EPA in 2001.
Iowa Creek—source to mouth ID17040104SK020_03	Combined Biota/Habitat Bioassessments; Habitat Assessment (streams); Cause Unknown	No	Delist for Combined Biota/Habitat Bioassessments, Habitat assessment (streams), and Cause Unknown. Move to Category 2.	Meets water quality targets; no pollutant pathways or sources of impairment found. Appears to be listing error based on ADB BURP info
Trout Creek—source to mouth ID17040104SK022_02	Sedimentation/Siltation	No	Delist for Sedimentation/ Siltation. Move to Category 2.	Meets water quality targets. No pollutant pathways or sources of impairment found. Forested/recreation lands. Listing error due to miscalculation of SFI BURP metric.
Indian Creek—Idaho/Wyoming border to Palisades Reservoir ID17040104SK024_04	Combined Biota/Habitat Bioassessments	Yes	Delist for Combined Biota/Habitat Bioassessments. Move to Category 4a.	Sediment determined to be the impairment; sediment load allocation developed.
Rainey Creek—source to mouth ID17040104SK028_04	Combined Biota/Habitat Bioassessments; Escherichia coli	Yes	List in Category 4a for *E. coli*.	Maintain Combined Biota/Habitat Bioassessments listing until further analysis can be completed.or BURP confirms beneficial use support. *E. coli* TMDL completed.

Water Body Segment/ Assessment Unit	Listed Pollutant(s)	TMDL Completed	Recommended Changes to Next Integrated Report	Justification
Pine Creek—source to mouth ID17040104SK029_03	Cause Unknown	No	Delist for Cause Unknown. Change to Combined Biota/Habitat Bioassessments and retain in Category 5	Meets water quality targets; no pollutant pathways or sources of impairment found. Forested/recreation lands. BURP will be conducted to determine if beneficial uses are now fully supported or other biological stressor analysis. Little to no site access and BURP not conducted in multiple years.
Black Canyon Creek—source to mouth ID17040104SK030_02	Sedimentation/Siltation	No	Delist for Sedimentation/Siltation. Move to Category 2	Meets sediment water quality targets. No pollutant pathways or sources of impairment found. Forested/recreation lands. Passed BURP in 2001 .

Table 16. Necessary load reductions for sediment-impaired assessment units in the Palisades Subbasin.

Water Body/ Assessment Unit	Current Load (tons/year)	Load Capacity (tons/year)	Load Allocation (tons/year)	Necessary Percent Reduction
Hawley Gulch Creek ID17040104SK001_02	17	10	7	41%
Table Rock Canyon Creek ID17040104SK001_02	7	3	4	57%
Lower Indian Creek ID17040104SK024_04	43	9	34	79%

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GIS Coverages

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Glossary

§303(d)

Refers to section 303 subsection "d" of the Clean Water Act. Section 303(d) requires states to develop a list of water bodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to US Environmental Protection Agency approval.

Aquatic

Occurring, growing, or living in water.

Assessment Unit (AU)

A segment of a water body that is treated as a homogenous unit, meaning that any designated uses, the rating of these uses, and any associated causes and sources must be applied to the entirety of the unit.

Beneficial Use

Any of the various uses of water, including, but not limited to, aquatic life, recreation, water supply, wildlife habitat, and aesthetics, which are recognized in water quality standards.

Beneficial Use Reconnaissance Program (BURP)

A program for conducting systematic biological and physical habitat surveys of water bodies in Idaho. BURP protocols address lakes, reservoirs, and wadeable streams and rivers.

Best Management Practices (BMPs)

Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.

Biological Integrity

1) The condition of an aquatic community inhabiting unimpaired water bodies of a specified habitat as measured by an evaluation of multiple attributes of the aquatic biota (EPA 1996). 2) The ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the natural habitats of a region (Karr 1991).

Biota

The animal and plant life of a given region.

Clean Water Act (CWA)

The Federal Water Pollution Control Act (commonly known as the Clean Water Act), as last reauthorized by the Water Quality Act of 1987, establishes a process for states to develop information on, and control the quality of, the nation's water resources.

Criteria

In the context of water quality, numeric or descriptive factors taken into account in setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels and to limit the number of violations per year. The US Environmental Protection Agency develops criteria guidance; states establish criteria.

Cubic Feet per Second (cfs)

A unit of measure for the rate of flow or discharge of water. One cubic foot per second is the rate of flow of a stream with a cross-section of one square foot flowing at a mean velocity of one foot per second. At a steady rate, 1 cfs is equal to 448.8 gallons per minute and 10,984 acre-feet per day.

Depth Fines

Percent by weight of particles of small size within a vertical core of volume of a streambed or lake bottom sediment. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 6.5 millimeters depending on the observer and methodology used. The depth sampled varies but is typically about 1 foot (30 centimeters).

Designated Uses

Those water uses identified in state water quality standards that must be achieved and maintained as required under the Clean Water Act.

Discharge

The amount of water flowing in the stream channel at the time of measurement. Usually expressed as cubic feet per second (cfs).

E. coli

Short for *Escherichia coli*, *E. coli* are a subspecies of coliform bacteria. Most *E. coli* are essential to the healthy life of all warm-blooded animals, including humans, but their presence in water is often indicative of fecal contamination. *E. coli* are used by the State of Idaho as the indicator for the presence of pathogenic microorganisms.

Environment

The complete range of external conditions, physical and biological, that affect a particular organism or community.

Erosion

The wearing away of areas of the earth's surface by water, wind, ice, and other forces.

Exceedance

A violation (according to DEQ policy) of the pollutant levels permitted by water quality criteria.

Existing Beneficial Use or Existing Use

A beneficial use actually attained in waters on or after November 28, 1975, whether or not the use is designated for the waters in Idaho's "Water Quality Standards" (IDAPA 58.01.02).

Extrapolation

Estimation of unknown values by extending or projecting from known values.

Fecal Coliform Bacteria

Bacteria found in the intestinal tracts of all warm-blooded animals or mammals. Their presence in water is an indicator of pollution and possible contamination by pathogens (also see *E. coli*).

Flow

See *Discharge*.

Fully Supporting

In compliance with water quality standards and within the range of biological reference conditions for all designated and exiting beneficial uses as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).

Fully Supporting Cold Water

Reliable data indicate functioning, sustainable cold water biological assemblages (e.g., fish, macroinvertebrates, or algae), none of which have been modified significantly beyond the natural range of reference conditions.

Geographic Information Systems (GIS)

A georeferenced database.

Geometric Mean

A back-transformed mean of the logarithmically transformed numbers often used to describe highly variable, right-skewed data (a few large values), such as bacterial data.

Gradient

The slope of the land, water, or streambed surface.

Ground Water

Water found beneath the soil surface saturating the layer in which it is located. Most ground water originates as rainfall, is free to move under the influence of gravity, and emerges again as streamflow.

Habitat

The living place of an organism or community.

Hydrologic Unit Code (HUC)

The number assigned to a hydrologic unit. Often used to refer to 4th-field hydrologic units.

Hydrology

The science dealing with the properties, distribution, and circulation of water.

Load Allocation (LA)

A portion of a water body's load capacity for a given pollutant that is given to a particular nonpoint source (by class, type, or geographic area).

Load(ing)

The quantity of a substance entering a receiving stream, usually expressed in pounds or kilograms per day or tons per year. Loading is the product of flow (discharge) and concentration.

Load(ing) Capacity (LC)

A determination of how much pollutant a water body can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, a margin of safety, and background contributions, it becomes a total maximum daily load.

Macroinvertebrate

An invertebrate animal (without a backbone) large enough to be seen without magnification and retained by a 500 micrometer mesh (US #30) screen.

Margin of Safety (MOS)

An implicit or explicit portion of a water body's load capacity set aside to allow for uncertainty about the relationship between the pollutant loads and the quality of the receiving water body. This is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL (generally within the calculations and/or models). The MOS is not allocated to any sources of pollution.

Mass Wasting

A general term for the down-slope movement of soil and rock material under the direct influence of gravity.

Mean

Describes the central tendency of a set of numbers. The arithmetic mean (calculated by adding all items in a list, then dividing by the number of items) is the statistic most familiar to most people.

Metric
1) A discrete measure of something, such as an ecological indicator (e.g., number of distinct taxon). 2) The metric system of measurement.

Monitoring
A periodic or continuous measurement of the properties or conditions of some medium of interest, such as monitoring a water body.

Mouth
The location where flowing water enters into a larger water body.

National Pollutant Discharge Elimination System (NPDES)
A national program established by the Clean Water Act for permitting point sources of pollution. Discharge of pollution from point sources is not allowed without a permit.

Nonpoint Source
A dispersed source of pollutants, generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point or origin. They include, but are not limited to, irrigated and nonirrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.

Nuisance
Anything that is injurious to the public health or an obstruction to the free use, in the customary manner, of any waters of the state.

Nutrient
Any substance required by living things to grow. An element or its chemical forms essential to life, such as carbon, oxygen, nitrogen, and phosphorus. Commonly refers to those elements in short supply, such as nitrogen and phosphorus, which usually limit growth.

Parameter
A variable, measurable property whose value is a determinant of the characteristics of a system (e.g., temperature, dissolved oxygen, and fish populations are parameters of a stream or lake).

Point Source
A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable “point” of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.

Pollutant
Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.

Pollution
A very broad concept that encompasses human-caused changes in the environment that alter the functioning of natural processes and produce undesirable environmental and health effects. This includes human-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.

Population
A group of interbreeding organisms occupying a particular space; the number of humans or other living creatures in a designated area.

Protocol	A series of formal steps for conducting a test or survey.
Quantitative	Descriptive of size, magnitude, or degree.
Reach	A stream section with fairly homogenous physical characteristics.
Reconnaissance	An exploratory or preliminary survey of an area.
Reference	A physical or chemical quantity whose value is known and used to calibrate or standardize instruments.
Reference Condition	1) A condition that fully supports applicable beneficial uses with little effect from human activity and represents the highest level of support attainable. 2) A benchmark for populations of aquatic ecosystems used to describe desired conditions in a biological assessment and acceptable or unacceptable departures from them. The reference condition can be determined through examining regional reference sites, historical conditions, quantitative models, and expert judgment (Hughes 1995).
Riparian	Associated with aquatic (stream, river, lake) habitats. Living or located on the bank of a water body.
River	A large, natural, or human-modified stream that flows in a defined course or channel or in a series of diverging and converging channels.
Runoff	The portion of rainfall, melted snow, or irrigation water that flows across the surface through shallow underground zones (interflow) and through ground water to create streams.
Sediments	Deposits of fragmented materials from weathered rocks and organic material that were suspended in, transported by, and eventually deposited by water or air.
Species	1) A reproductively isolated aggregate of interbreeding organisms having common attributes and usually designated by a common name. 2) An organism belonging to such a category.
Stream	A natural water course containing flowing water, at least part of the year. Together with dissolved and suspended materials, a stream normally supports communities of plants and animals within the channel and the riparian vegetation zone.
Stormwater Runoff	Rainfall that quickly runs off the land after a storm. In developed watersheds, the water flows off roofs and pavement into storm drains that may feed quickly and directly into the stream. The water often carries pollutants picked up from these surfaces.

Subbasin

A large watershed of several hundred thousand acres. This is the name commonly given to 4th-field hydrologic units (also see *Hydrologic Unit*).

Subbasin Assessment (SBA)

A watershed-based problem assessment that is the first step in developing a total maximum daily load in Idaho.

Subwatershed

A smaller watershed area delineated within a larger watershed, often for purposes of describing and managing localized conditions. Also proposed for adoption as the formal name for 6th-field hydrologic units.

Surface Water

All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors that are directly influenced by surface water.

Total Maximum Daily Load (TMDL)

A TMDL is a water body's load capacity after it has been allocated among pollutant sources. It can be expressed on a time basis other than daily if appropriate. Sediment loads, for example, are often calculated on an annual bases. A TMDL is equal to the load capacity, such that load capacity = margin of safety + natural background + load allocation + wasteload allocation = TMDL. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.

Tributary

A stream feeding into a larger stream or lake.

Wasteload Allocation (WLA)

The portion of receiving water's load capacity that is allocated to one of its existing or future point sources of pollution. Wasteload allocations specify how much pollutant each point source may release to a water body.

Water Body

A stream, river, lake, estuary, coastline, or other water feature, or portion thereof.

Water Column

Water between the interface with the air at the surface and the interface with the sediment layer at the bottom. The idea derives from a vertical series of measurements (oxygen, temperature, phosphorus) used to characterize water.

Water Pollution

Any alteration of the physical, thermal, chemical, biological, or radioactive properties of any waters of the state, or the discharge of any pollutant into the waters of the state, which will or is likely to create a nuisance or to render such waters harmful, detrimental, or injurious to public health, safety, or welfare; to fish and wildlife; or to domestic, commercial, industrial, recreational, aesthetic, or other beneficial uses.

Water Quality

A term used to describe the biological, chemical, and physical characteristics of water with respect to its suitability for a beneficial use.

Water Quality Criteria

Levels of water quality expected to render a water body suitable for its designated uses. Criteria are based on specific levels of pollutants that would

	make the water harmful if used for drinking, swimming, farming, or industrial processes.
Water Quality Limited	A label that describes water bodies for which one or more water quality criterion is not met or beneficial uses are not fully supported. Water quality limited segments may or may not be on a §303(d) list.
Water Quality Standards	State-adopted and US Environmental Protection Agency-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.
Watershed	1) All the land that contributes runoff to a common point in a drainage network or to a lake outlet. Watersheds are infinitely nested, and any large watershed is composed of smaller "subwatersheds." 2) The whole geographic region that contributes water to a point of interest in a water body.
Wetland	An area that is at least some of the time saturated by surface or ground water so as to support vegetation adapted to saturated soil conditions. Examples include swamps, bogs, fens, and marshes.

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Appendix A. Unit Conversion Chart

Table A-1. Metric–English unit conversions.

	English Units	Metric Units	To Convert	Example
Distance	Miles (mi)	Kilometers (km)	1 mi = 1.61 km 1 km = 0.62 mi	3 mi = 4.83 km 3 km = 1.86 mi
Length	Inches (in) Feet (ft)	Centimeters (cm) Meters (m)	1 in = 2.54 cm 1 cm = 0.39 in 1 ft = 0.30 m 1 m = 3.28 ft	3 in = 7.62 cm 3 cm = 1.18 in 3 ft = 0.91 m 3 m = 9.84 ft
Area	Acres (ac) Square feet (ft^2) Square miles (mi^2)	Hectares (ha) Square meters (m^2) Square kilometers (km^2)	1 ac = 0.40 ha 1 ha = 2.47 ac 1 ft^2 = 0.09 m^2 1 m^2 = 10.76 ft^2 1 mi^2 = 2.59 km^2 1 km^2 = 0.39 mi^2	3 ac = 1.20 ha 3 ha = 7.41 ac 3 ft^2 = 0.28 m^2 3 m^2 = 32.29 ft^2 3 mi^2 = 7.77 km^2 3 km^2 = 1.16 mi^2
Volume	Gallons (gal) Cubic feet (ft^3)	Liters (L) Cubic meters (m^3)	1 gal = 3.78 L 1 L= 0.26 gal 1 ft^3 = 0.03 m^3 1 m^3 = 35.32 ft^3	3 gal = 11.35 L 3 L = 0.79 gal 3 ft^3 = 0.09 m^3 3 m^3 = 105.94 ft^3
Flow Rate	Cubic feet per second (cfs)[a]	Cubic meters per second (m^3/sec)	1 cfs = 0.03 m^3/sec 1 m^3/sec = 35.31 cfs	3 cfs = 0.09 m^3/sec 3 m^3/sec = 105.94 cfs
Concentration	Parts per million (ppm)	Milligrams per liter (mg/L)	1 ppm = 1 mg/L[b]	3 ppm = 3 mg/L
Weight	Pounds (lb)	Kilograms (kg)	1 lb = 0.45 kg 1 kg = 2.20 lb	3 lb = 1.36 kg 3 kg = 6.61 lb
Temperature	Fahrenheit (°F)	Celsius (°C)	°C = 0.55 (F - 32) °F = (C x 1.8) + 32	3 °F = -15.95 °C 3 °C = 37.4 °F

[a] 1 cfs = 0.65 million gallons per day; 1 million gallons per day = 1.55 cfs.
[b] The ratio of 1 ppm = 1 mg/L is approximate and is only accurate for water.

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Appendix B. Data Sources

Location	Data Source	Data Type	Collection Date
Palisades Subbasin	Idaho Falls Regional Offices	Streambank erosion inventories	July 2010
Palisades Subbasin	United States Forest Service	Water quality improvement projects	2006–2010
Burns Creek, Palisades Creek, Pine Creek, and Rainey Creek	Idaho Department of Fish and Game	Fish weirs	2008–2010
Rainey Creek	Trout Unlimited	Restoration project	2006–2008
Rainey Creek	Idaho Falls Regional Office	*E. Coli*	August1999

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Appendix C. Erosion Inventory Methodology and Results

Streambank Erosion Inventory

The streambank erosion inventory used to estimate background and existing streambank erosion followed methods outlined in the proceedings from the Natural Resources Conservation Service (NRCS) Channel Evaluation Workshop (NRCS 1983). Using the direct volume method, subsections of 1998§303(d)-listed water bodies were surveyed to determine the extent of chronic bank erosion and estimate the needed reductions.

The NRCS streambank erosion inventory is a field-based methodology that measures streambank/channel stability, length of active eroding banks, and bank geometry (Stevenson 1994). The streambank/channel stability inventories were used to estimate the long-term lateral recession rate. The recession rate is determined from field evaluation of streambank characteristics that are assigned a categorical rating from 0 to 3. The rating categories and scores are as follows:

Bank Stability:

- Do not appear to be eroding—0
- Erosion evident—1
- Erosion and cracking present—2
- Slumps and clumps sloughing off—3

Bank Condition:

- Some bare bank, few rills, no vegetative overhang—0
- Predominantly bare, some rills, moderate vegetative overhang—1
- Bare, rills, severe vegetative overhang, exposed roots—2
- Bare, rills and gullies, severe vegetative overhang, falling trees—3

Vegetation/Cover On Banks:

- Predominantly perennials or rock-covered—0
- Annuals/perennials mixed or about 40% bare—1
- Annuals or about 70% bare—2
- Predominantly bare—3

Bank/Channel Shape:

- V-shaped channel, sloped banks—0
- Steep v-shaped channel, near vertical banks—1
- Vertical banks, u-shaped channel—2
- U-shaped channel, undercut banks, meandering channel—3

Channel Bottom:

- Channel in bedrock / noneroding—0
- Soil bottom, gravels or cobbles, minor erosion—1
- Silt bottom, evidence of active downcutting—2

Deposition:

- Evidence of recent deposits, silt bars—0
- No evidence of recent deposition—1

Cumulative Rating

- Slight (0–4)
- Moderate (5–8)
- Severe (9+)

From the cumulative rating, the lateral recession rate is assigned as follows:

- 0.01–0.05 feet per year—**Slight**
- 0.06–0.15 feet per year—**Moderate**
- 0.16–0.3 feet per year—**Severe**
- 0.5+ feet per year—**Very Severe**

Streambank stability can also be characterized through the following definitions; corresponding streambank erosion condition ratings from the bank stability or bank condition categories above are included in italics. Streambanks are considered stable if they do not show indications of any of the following features:

- **Breakdown**—Obvious blocks of bank broken away and lying adjacent to the bank breakage. *Bank Stability Rating 3*
- **Slumping or False Bank**—Bank has obviously slipped down; cracks may or may not be obvious, but the slump feature is obvious. *Bank Stability Rating 2*
- **Fracture**—A crack is visibly obvious on the bank indicating that the block of bank is about to slump or move into the stream. *Bank Stability Rating 2*
- **Vertical and Eroding**—The bank is mostly uncovered and the bank angle is steeper than 80 degrees from the horizontal. *Bank Stability Rating 1*

Streambanks are considered covered if they show any of the following features:

- Perennial vegetation groundcover is greater than 50%. *Vegetation/Cover Rating 0*
- Roots of vegetation cover more than 50% of the bank (deep-rooted plants such as willows and sedges provide such root cover). *Vegetation/Cover Rating 1*
- At least 50% of the bank surfaces are protected by rocks of cobble size or larger. *Vegetation/Cover Rating 0*
- At least 50% of the bank surfaces are protected by logs 4-inch diameter or larger. *Vegetation/Cover Rating 1*

Streambank stability is estimated using a simplified modification of Platts, Megahan, and Minshall (1983, 13) as stated in *Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management on Western Rangeland Streams* (Bauer and Burton 1993). The modification allows for measuring streambank stability in a more objective fashion. Bank length on both sides of the stream throughout the entire linear distance of the representative reach are measured and proportioned into four stability classes as follows:

- **Mostly covered and stable (nonerosional).** Streambanks are greater than 50% covered as defined above. Streambanks are stable as defined above. Banks associated with gravel bars having perennial vegetation above the scourline are in this category. *Cumulative rating 0–4 (slight erosion) with a corresponding lateral recession rate of 0.01–0.05 feet per year.*

- **Mostly covered and unstable (vulnerable).** Streambanks are greater than 50% covered as defined above. Streambanks are unstable as defined above. Such banks are typical of false banks observed in meadows where breakdown, slumping, and/or fracture show instability yet vegetative cover is abundant. *Cumulative rating 5–8 (moderate erosion) with a corresponding lateral recession rate of 0.06–0.2 feet per year.*
- **Mostly uncovered and stable (vulnerable).** Streambanks are less than 50% covered as defined above. Streambanks are stable as defined above. Uncovered, stable banks are typical of streambanks trampled by concentrations of cattle. Such trampling flattens the bank so that slumping and breakdown do not occur even though vegetative cover is significantly reduced or eliminated. *Cumulative rating 5–8 (moderate erosion) with a corresponding lateral recession rate of 0.06–0.2 feet per year.*
- **Mostly uncovered and unstable (erosional).** Streambanks are less than 50% covered as defined above. They are also unstable as defined above. These are bare eroding streambanks and include **all** banks mostly uncovered, which are at a steep angle to the water surface. *Cumulative rating 9+ (severe erosion) with a corresponding lateral recession rate of over 0.5 feet per year.*

Streambanks were inventoried to quantify bank erosion rate and annual average erosion. These data were used to develop a quantitative sediment budget to be used for TMDL development.

Site Selection

The first step in the bank erosion inventory is to identify key problem areas. Streambank erosion tends to increase as a function of watershed area (NRCS 1983). As a result, the lower stream segments of larger watersheds tend to be problem areas. These stream segments tend to be alluvial streams commonly classified as response reaches (Rosgen B and C channel types) (Rosgen 1996).

Because it is often unrealistic to survey every stream segment, sampled reaches were used and bank erosion rates were extrapolated over a larger stream segment. The length of the sampled reach was a function of stream type variability where stream segments with highly variable channel types need a large sample, whereas segments with uniform gradient and consistent geometry need less. Typically, between 10 and 30% percent of a streambank needs to be inventoried. The location of some stream inventory reaches is more dependent on landownership than watershed characteristics. For example, private landowners are sometimes unwilling to allow access to stream segments on their property. Stream reaches were subdivided into *sites* with similar channel and bank characteristics. Breaks between sites were made where channel type and/or dominate bank characteristics changed substantially. In a stream with uniform channel geometry, there may be only one site per stream reach, whereas an area with variable conditions may have several sites. Subdivision of stream reaches was at the discretion of the field crew leader.

Field Methods

Streambank erosion or channel stability inventory field methods were originally developed by the United States Forest Service (Pfankuch 1975). Further development of channel stability inventory methods are outlined in Lohrey (1989) and NRCS (1983). As stated above, the NRCS (1983) document outlines field methods used in this inventory. However, slight modifications to the field methods were made and are documented.

Field crews typically consist of two to four people who are trained as a group to ensure quality control or consistent data collection. Field crews surveyed selected stream reaches measuring bank length, slope height, bank-full width and depth, and bank content. In most cases, a GPS was used to locate the upper and lower boundaries of inventoried stream reaches. While surveying, field crews also photographed key problem areas.

Bank Erosion Calculations

The direct volume method was used to calculate average annual erosion rates for a given stream segment based on bank recession rate determined in the survey (NRCS 1983). The erosion rate (tons/mile/year) was used to estimate the total bank erosion of the selected stream corridor.

The direct volume method is summarized in the following equations:

$$E = [A_E * R_{LR} * \text{\_}_B]/2000 \text{ (lb/ton)}$$

where:

E = bank erosion over sampled stream reach (tons/year/sample reach)

A_E = eroding area (ft^2)

R_{LR} = lateral recession rate (ft/year)

__B = bulk density of bank material (lb/ft^3)

The bank erosion rate (E_R) is calculated by dividing the sampled bank erosion (E) by the total stream length sampled:

$$E_R = E/L_{BB}$$

where:

E_R = bank erosion rate (tons/mile/year)

E = bank erosion over sampled stream reach (tons/year/sample reach)

L_{BB} = bank-to-bank stream length over sampled reach

Total bank erosion is expressed as an annual average. However, the frequency and magnitude of bank erosion events are a function of soil moisture and stream discharge (Leopold et al. 1964). Because channel erosion events typically result from above average flow events, the annual average bank erosion value should be considered a long-term average. For example, a 50-year flood event might cause 5 feet of bank erosion in 1 year, and over a 10-year period this event accounts for the majority of bank erosion. These factors have less of an influence where bank trampling is the major cause of channel instability.

The eroding area (A_E) is the product of linear horizontal bank distance and average bank slope height. Bank length and slope heights were measured while walking along the stream channel. Pacing was used to measure horizontal distance, and bank slope heights were continually measured and averaged over a given reach or site. The horizontal length is the length of the right or left bank, not both. Typically, one bank along the stream channel is actively eroding (e.g., the bank on the outside of a meander). However, both banks of channels with severe headcuts or gullies will be eroding and are to be measured separately and eventually summed.

Determining the lateral recession rate (R_{LR}) is one of the most critical factors in this methodology (NRCS 1983). Several techniques are available to quantify bank erosion rates (e.g., aerial photo interpretation, anecdotal data, bank pins, and channel cross sections).

To facilitate consistent data collection, the NRCS developed rating factors used to estimate lateral recession rate. Similar to methods developed by Pfankuch (1975), the NRCS method measures bank and channel stability, then uses the ratings as surrogates for bank erosion rates.

The bulk density ($_B$) of bank material is measured ocularly in the field. Soil bulk density is the weight of material divided by its volume, including the volume of its pore spaces. A table of typical soil bulk densities can be used, or soil samples can be collected and soil bulk density measured in the laboratory.

Erosion Inventory Results

Results of the streambank erosion inventories are presented in Figures C1–C11.

Stream Bank Erosion Inventory Worksheet	
Stream	Hawley Gulch Creek
Section	
Land Use	Forest/Recreation
Field Crew	Aaron Swift, Jack Rainey

Stream Segment Location	
GPS Coordinates	
Upstream	N 43.62977
	W 111.58948
Downstream	N 43.63368
	W 111.58812

Stream Bank Erosion Calculations		
AVE. Bank Height:	4.9	feet
bank to bank Eroding Seg. Length	518	feet
Percent eroding bank	0.17	
Bank erosion over sampled reach (E)	17	tons/year/sample reach
Erosion Rate (ER)	58	tons/mile/year
Feet of Similar Stream Type	25344	feet
Eroding bank extrapolation	9015.21	feet
Total stream bank erosion	**293**	tons/year
Inv. bank to bank length (LBB)	3090	feet

Individual Bank Measurements

Total Inventoried Length	Bank	Erosive Bank Lngth	Average Bank Slope Hgt	Bank Material	Recession Rank
1545		23	3.9	Gravel/Cobble	6
		29.5	6.6		
		6.6	6.6		
		32.8	4.6		
		52.5	13.1		
		85.3	6.6		
		19.7	6.6		
		26.2	6.6		
		23	1.6		
		13.1	2.0		
		32.8	3.3		
		26.2	3.0		
		19.7	3.3		
		6.6	6.6		
		13.1	2.3		
		23	5.2		
		19.7	6.6		
		32.8	6.6		
		3.3	3.3		
		6.6	2.6		
		9.8	3.3		
		13.1	3.9		
1545		518.4	4.9	sec. total	6
				Recession Rate	0.06
Total Inventoried Length		Total Erosive Length			
1545		518.4	4.92	Ave. Rec.Rank	6
				Ave. Rec.Rate	0.060

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	10	tons/year/sample reach
Erosion Rate (ER)	34	tons/mile/year
Feet of Similar Stream Types	25344.00	feet
Eroding bank extrapolation	10755.60	feet
Total stream bank erosion	**174.6**	tons/year

Eroding Area	Reach erosion rate		Eroding Area with Load Reductions	Load Capacity	
5099.170909	16.827	tons/year	3039.4	10.030	tons/year
Recession Rate			Recession Rate		
0.06			0.06		
Bulk Density			Bulk Density		
110			110	Total for segments after reduction	
	16.827	tons/year		10.030	tons/year/sample
	Current loading rate			Load Allocation	
Eroding Area	**Average Reach erosion rate**			**Total Reduction**	
5099	16.827	**tons/year/sample**		6.797	**tons/year/sample**
Recession Rate					
0.06					
Avg. Bulk Density					
110					

Figure C1. Hawley Gulch Creek streambank erosion inventory worksheet.

Stream Bank Erosion Inventory Worksheet	
Stream	Table Rock Canyon Creek
Section	
Land Use	Forest/Recreation
Field Crew	Aaron Swift, Jack Rainey

Stream Segment Location	
GPS Coordinates	
Upstream	N 43.62098
	W 111.58018
Downstream	N 43.62297
	W 111.58327

Stream Bank Erosion Calculations		
AVE. Bank Height:	1.5	feet
bank to bank Eroding Seg. Length	669	feet
Percent eroding bank	0.24	
Bank erosion over sampled reach (E)	7	tons/year/sample reach
Erosion Rate (ER)	25	tons/mile/year
Feet of Similar Stream Type	26136	feet*
Eroding bank extrapolation	13149.36	feet
Total stream bank erosion	**133**	tons/year
Inv. bank to bank length (LBB)	2802	feet

(Inventoried stream length X 2)

*Similar stream type = Strahler 2nd order streams in ID17040104SK001_02

1st order presumed non-erosive

Total Inventoried Length	Bank Erosive Bank Lngth	Average Bank Slope Hgt	Bank Material	Recession Rank
1401	72.2	1.6	Gravel/Cobble	5
	13.1	0.6		
	9.8	1.0		
	16.4	2.0		
	32.8	1.6		
	26.2	2.0		
	19.7	2.0		
	45.9	1.0		
	6.6	0.5		
	16.4	2.0		
	45.9	2.0		
	19.7	2.0		
	26.2	1.0		
	52.5	4.0		
	19.7	2.0		
	16.4	2.0		
	6.6	1.6		
	39.4	1.0		
	45.9	2.0		
	6.6	0.6		
	39.4	0.6		
	45.9	2.0		
	6.6	0.6		
	6.6	0.0		
	26.2	2.0		
	6.6	0.6		
1401	669.3	1.5	sec. total	5
			Recession Rate	0.06
Total Inventoried Length	Total Erosive Length			
1401	669.3	1.5	Ave. Rec.Rank	5
			Ave. Rec.Rate	0.06

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	3	tons/year/sample reach
Erosion Rate (ER)	10	tons/mile/year
Feet of Similar Stream Types	26136.00	feet
Eroding bank extrapolation	11014.80	feet
Total stream bank erosion	**53.6**	tons/year

Eroding Area	Reach erosion rate		Eroding Area with Load Reductions	Load Capacity	
1974.409512	6.516	tons/year	826.6	2.728	tons/year
Recession Rate			Recession Rate		
0.06			0.06		
Bulk Density			Bulk Density		
110			110	Total for segments after reduction	
	6.516	tons/year		2.728	tons/year/sample

	Current loading rate		Load Allocation	
Eroding Area	**Average Reach erosion rate**		**Total Reduction**	
2043	6.743	**tons/year/sample**	3.788	**tons/year/sample**
Recession Rate				
0.06				
Avg. Bulk Density				
110				

Figure C2. Table Rock Canyon Creek streambank erosion inventory worksheet.

Stream Bank Erosion Inventory Worksheet

Stream	Squaw Creek
Section	
Land Use	Forest/Grazing
Field Crew	Aaron Swift, Jack Rainey

Stream Segment Location

GPS Coordinates	
Upstream	N 43.41506
	W 111.337450
Downstream	N 43.41151
	W 111.33908

Stream Bank Erosion Calculations

AVE. Bank Height:	0.3	feet
bank to bank Eroding Seg. Length	5	feet
Percent eroding bank	0.00	
Bank erosion over sampled reach (E)	0	tons/year/sample reach
Erosion Rate (ER)	0	tons/mile/year
Feet of Similar Stream Type	41184	feet*
Eroding bank extrapolation	161.36	feet
Total stream bank erosion	**0**	tons/year
Inv. bank to bank length (LBB)	2634	feet
(Inventoried stream length X 2)		

*Similar stream type = Strahler 2nd order streams in ID17040104SK008_02

Individual Bank Measurements

Total Inventoried Length	Bank Erosive Bank Lngth	Average Bank Slope Hgt	Bank Material	Recession Rank
1317	2.0	0.2	Sand	1
	3.0	0.3		
1317	5.0	0.3	sec. total	1
			Recession Rate	0.01
Total Inventoried Length	Total Erosive Length			
1317	5.0	0.3	Ave. Rec.Rank	1
			Ave. Rec.Rate	0.010

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	0	tons/year/sample reach
Erosion Rate (ER)	2	tons/mile/year
Feet of Similar Stream Types	41184.00	feet
Eroding bank extrapolation	17000.40	feet
Total stream bank erosion	**13.4**	tons/year

Eroding Area	Reach erosion rate		Eroding Area with Load Reductions	Load Capacity	
2.5	0.001	tons/year	131.7	0.415	tons/year
Recession Rate			Recession Rate		
0.01			0.06		
Bulk Density			Bulk Density		
105			105	Total for segments after reduction	
	0.001	tons/year		0.415	tons/year/sample
	Current loading rate			Load Allocation	
Eroding Area	**Average Reach erosion rate**			**Total Reduction**	
3	0.001	**tons/year/sample**		-0.414	**tons/year/sample**
Recession Rate					
0.01					
Avg. Bulk Density					
105					

Figure C3. Squaw Creek streambank erosion inventory worksheet.

Stream Bank Erosion Inventory Worksheet	
Stream	Iowa Creek
Section	
Land Use	Forest/Mining
Field Crew	Aaron Swift, Jack Rainey

Stream Segment Location	
GPS Coordinates	
Upstream	N 43.147786
	W 111.247234
Downstream	N 43.145716
	W 111.249679

Stream Bank Erosion Calculations		
AVE. Bank Height:	0.5	feet
bank to bank Eroding Seg. Length	15	feet
Percent eroding bank	0.01	
Bank erosion over sampled reach (E)	0	tons/year/sample reach
Erosion Rate (E_R)	0	tons/mile/year
Feet of Similar Stream Type	12144	feet*
Eroding bank extrapolation	136.44	feet
Total stream bank erosion	**0**	tons/year
Inv. bank to bank length (L_{BB})	3000	feet
(Inventoried stream length X 2)		

*Similar stream type = Strahler 3rd order streams in ID17040104SK020_03

Individual Bank Measurements				
Total Inventoried Bank Length	Erosive Bank Lngth	Average Bank Slope Hgt	Bank Material	Recession Rank
1500	2.0	0.2	Sand	1
	3.0	0.3		
	4.0	0.6		
	6.0	1.0		
1500	15.0	0.5	sec. total	1
			Recession Rate	0.01
Total Inventoried Length	Total Erosive Length			
1500	15.0	0.5	Ave. Rec.Rank	1
			Ave. Rec.Rate	0.010

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	1	tons/year/sample reach
Erosion Rate (E_R)	3	tons/mile/year
Feet of Similar Stream Types	12144.00	feet
Eroding bank extrapolation	5457.60	feet
Total stream bank erosion	**9.0**	tons/year

Eroding Area	Reach erosion rate		Eroding Area with Load Reductions	Load Capacity	
15.75	0.008	tons/year	315.0	0.992	tons/year
Recession Rate			Recession Rate		
0.01			0.06		
Bulk Density			Bulk Density		
105			105	Total for segments after reduction	
	0.008	tons/year		0.992	tons/year/sample
	Current loading rate			Load Allocation	
Eroding Area	**Average Reach erosion rate**			**Total Reduction**	
16	0.008	**tons/year/sample**		-0.984	**tons/year/sample**
Recession Rate					
0.01					
Avg. Bulk Density					
105					

Figure C4. Iowa Creek streambank erosion inventory worksheet.

Stream Bank Erosion Inventory Worksheet	
Stream	Trout Creek
Section	
Land Use	Forest/Recreation
Field Crew	Aaron Swift, Jack Rainey

Stream Segment Location		
GPS Coordinates		
Upstream	N 43.15861	
	W 111..07139	
Downstream	N 43.15517	
	W 111.07246	

Stream Bank Erosion Calculations		
AVE. Bank Height:	3.0	feet
bank to bank Eroding Seg. Length	345	feet
Percent eroding bank	0.12	
Bank erosion over sampled reach (E)	6	tons/year/sample reach
Erosion Rate (E_R)	20	tons/mile/year
Feet of Similar Stream Type	4382	feet*
Eroding bank extrapolation	1352.86	feet
Total stream bank erosion	**22**	tons/year
Inv. bank to bank length (L_{BB})	3000	feet
	(Inventoried stream length X 2)	

*Similar stream type = Strahler 2nd order streams in ID17040104SK022_02

Individual Bank Measurements

Total Inventoried Bank Length	Erosive Bank Lngth	Average Bank Slope Hgt	Bank Material	Recession Rank
1500	39.4	3.9	Gravel	4
	6.6	1.6		
	6.6	3.3		
	6.6	1.6		
	9.8	3.3		
	13.1	1.0		
	16.4	5.2		
	16.4	3.9		
	4.9	3.3		
	13.1	1.6		
	45.9	4.6		
	6.6	2.6		
	19.7	2.3		
	26.2	2.0		
	13.1	4.6		
	23.0	3.9		
	26.2	2.3		
	16.4	2.0		
	19.7	3.9		
	4.9	2.3		
	9.8	3.3		
1500	344.5	3.0	sec. total	4
			Recession Rate	0.05
Total Inventoried Length	Total Erosive Length			
1500	344.5	3.0	Ave. Rec.Rank	4
			Ave. Rec.Rate	0.05

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	6	tons/year/sample reach
Erosion Rate (E_R)	21	tons/mile/year
Feet of Similar Stream Types	4382.00	feet
Eroding bank extrapolation	2352.80	feet
Total stream bank erosion	**23.2**	tons/year

Eroding Area	Reach erosion rate		Eroding Area with Load Reductions	Load Capacity	
2055.907021	5.654	tons/year	1790.4	5.908	tons/year
Recession Rate			Recession Rate		
0.05			0.06		
Bulk Density			Bulk Density		
110			110	Total for segments after reduction	
	5.654	tons/year		5.908	tons/year/sample
	Current loading rate			Load Allocation	
Eroding Area	**Average Reach erosion rate**			**Total Reduction**	
2036	5.599	**tons/year/sample**		-0.255	**tons/year/sample**
Recession Rate					
0.05					
Avg. Bulk Density					
110					

Figure C5. Trout Creek streambank erosion inventory worksheet.

Stream Bank Erosion Inventory Worksheet	
Stream	South Fork Indian Creek
Section	
Land Use	Forest/Recreation
Field Crew	Aaron Swift, Jack Rainey

Stream Segment Location	
GPS Coordinates	
Upstream	N 43.25740
	W 111..05991
Downstream	N 43.25583
	W 111.05640

Stream Bank Erosion Calculations		
AVE. Bank Height:	0.6	feet
bank to bank Eroding Seg. Length	312	feet
Percent eroding bank	0.10	
Bank erosion over sampled reach (E)	1	tons/year/sample reach
Erosion Rate (ER)	3	tons/mile/year
Feet of Similar Stream Type	5280	feet*
Eroding bank extrapolation	1328.89	feet
Total stream bank erosion	**3**	tons/year
Inv. bank to bank length (LBB)	3240	feet
(Inventoried stream length X 2)		

*Similar stream type = Strahler 2nd order streams in ID17040104SK022_02

Total Inventoried Bank Length	Erosive Bank Lngth	Average Bank Slope Hgt	Bank Material	Recession Rank
1620	49.2	1.0	Gravel/Cobble	3
	45.9	0.5		
	13.1	0.5		
	39.4	0.6		
	32.8	0.4		
	9.8	0.3		
	19.7	0.4		
	32.8	0.3		
	23.0	0.6		
	9.8	0.5		
	9.8	1.0		
	26.2	1.0		
1620	311.7	0.6	sec. total	3
			Recession Rate	0.04
Total Inventoried Length	Total Erosive Length			
1620	311.7	0.6	Ave. Rec.Rank	3
			Ave. Rec.Rate	0.04

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	1	tons/year/sample reach
Erosion Rate (ER)	4	tons/mile/year
Feet of Similar Stream Types	5280.00	feet
Eroding bank extrapolation	2760.00	feet
Total stream bank erosion	**5.4**	tons/year

Eroding Area	Reach erosion rate		Eroding Area with Load Reductions	Load Capacity	
368.8210967	0.811	tons/year	383.4	1.265	tons/year
Recession Rate			Recession Rate		
0.04			0.06		
Bulk Density			Bulk Density		
110			110	Total for segments after reduction	
	0.811	tons/year		1.265	tons/year/sample
	Current loading rate			Load Allocation	
Eroding Area	**Average Reach erosion rate**			**Total Reduction**	
369	0.811	**tons/year/sample**		-0.454	**tons/year/sample**
Recession Rate					
0.04					
Avg. Bulk Density					
110					

Figure C6. South Fork Indian Creek streambank erosion inventory worksheet.

Stream Bank Erosion Inventory Worksheet	
Stream	Main Stem Indian Creek
Section	
Land Use	Forest/Recreation
Field Crew	Aaron Swift, Jack Rainey

Stream Segment Location	
GPS Coordinates	
Upstream	N 43.25960
	W 111.06516
Downstream	N 43.26126
	W 111.06089

Stream Bank Erosion Calculations		
AVE. Bank Height:	3.6	feet
bank to bank Eroding Seg. Length	236	feet
Percent eroding bank	0.07	
Bank erosion over sampled reach (E)	4	tons/year/sample reach
Erosion Rate (E_R)	11	tons/mile/year
Feet of Similar Stream Type	5280	feet*
Eroding bank extrapolation	935.26	feet
Total stream bank erosion	**15**	tons/year
Inv. bank to bank length (L_{BB})	3564	feet

(Inventoried stream length X 2)

*Similar stream type = Strahler 3rd order streams in ID17040104SK024_03

Individual Bank Measurements

Total Inventoried Bank Length	Erosive Bank Lngth	Average Bank Slope Hgt	Bank Material	Recession Rank
1782	19.7	0.7	Gravel	3
	39.4	4.9		
	13.1	3.3		
	13.1	3.9		
	9.8	6.6		
	9.8	4.3		
	52.5	1.6		
	65.6	6.6		
	6.6	3.3		
	6.6	1.0		
1782	236.2	3.6	sec. total	3
			Recession Rate	0.04
Total Inventoried Length	Total Erosive Length			
1782	236.2	3.6	Ave. Rec.Rank	3
			Ave. Rec.Rate	0.04

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	8	tons/year/sample reach
Erosion Rate (E_R)	25	tons/mile/year
Feet of Similar Stream Types	5280.00	feet
Eroding bank extrapolation	2824.80	feet
Total stream bank erosion	**33.6**	tons/year

Eroding Area	Reach erosion rate		Eroding Area with Load Reductions	Load Capacity	
1705.003519	3.751	tons/year	2572.4	8.489	tons/year
Recession Rate			Recession Rate		
0.04			0.06		
Bulk Density			Bulk Density		
110			110	Total for segments after reduction	
	3.751	tons/year		8.489	tons/year/sample
	Current loading rate			Load Allocation	
Eroding Area	**Average Reach erosion rate**			**Total Reduction**	
1705	3.751	**tons/year/sample**		-4.738	**tons/year/sample**
Recession Rate					
0.04					
Avg. Bulk Density					
110					

Figure C7. Main fork Indian Creek streambank erosion inventory worksheet.

Stream Bank Erosion Inventory Worksheet	
Stream	Lower Indian Creek
Section	
Land Use	Forest/Recreation
Field Crew	Aaron Swift, Jack Rainey

Stream Segment Location	
GPS Coordinates	
Upstream	N 43.254313
	W 111.085145
Downstream	N 43.254852
	W 111.081932

Stream Bank Erosion Calculations		
AVE. Bank Height:	5.2	feet
bank to bank Eroding Seg. Length	833	feet
Percent eroding bank	0.32	
Bank erosion over sampled reach (E)	43	tons/year/sample reach
Erosion Rate (ER)	174	tons/mile/year
Feet of Similar Stream Type	6585	feet*
Eroding bank extrapolation	5052.47	feet
Total stream bank erosion	**260**	tons/year
Inv. bank to bank length (LBB)	2600	feet
(Inventoried stream length X 2)		
*Similar stream type = Strahler 2nd order streams in ID17040104SK024_04		

Individual Bank Measurements

Total Inventoried Bank Length	Erosive Bank Lngth	Average Bank Slope Hgt	Bank Material	Recession Rank
1300	65.6	9.8	Gravel	6
	19.7	6.6		
	26.2	3.3		
	39.4	2.0		
	45.9	3.3		
	9.8	6.6		
	19.7	3.3		
	16.4	3.3		
	49.2	6.6		
	59.1	6.6		
	65.6	6.6		
	19.7	2.6		
	26.2	3.3		
	32.8	2.0		
	39.4	2.6		
	32.8	6.6		
	49.2	9.8		
	19.7	3.3		
	45.9	3.3		
	52.5	6.6		
	65.6	6.6		
	32.8	9.8		
1300	833.3	5.2	sec. total	6
			Recession Rate	0.09
Total Inventoried Length	Total Erosive Length			
1300	833.3	5.2	Ave. Rec.Rank	6
			Ave. Rec.Rate	0.09

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	9	tons/year/sample reach
Erosion Rate (ER)	36	tons/mile/year
Feet of Similar Stream Types	6585.00	feet
Eroding bank extrapolation	3154.00	feet
Total stream bank erosion	**54.0**	tons/year

Eroding Area	Reach erosion rate		Eroding Area with Load Reductions	Load Capacity	
8649.48755	42.815	tons/year	2698.6	8.906	tons/year
Recession Rate			Recession Rate		
0.09			0.06		
Bulk Density			Bulk Density		
110			110	Total for segments after reduction	
	42.815	tons/year		8.906	tons/year/sample
	Current loading rate			Load Allocation	
Eroding Area	**Average Reach erosion rate**			**Total Reduction**	
8649	42.815	**tons/year/sample**		33.909	**tons/year/sample**
Recession Rate					
0.09					
Avg. Bulk Density					
110					

Figure C8. Lower Indian Creek streambank erosion inventory worksheet.

Stream Bank Erosion Inventory Worksheet	
Stream	Indian Creek/Fall Creek Road
Section	
Land Use	BLM/Grazing
Field Crew	Aaron Swift, Jack Rainey

Stream Segment Location	
GPS Coordinates	
Upstream	N 43.40722
	W 111.32121
Downstream	N 43.40452
	W 111.32401

Stream Bank Erosion Calculations		
AVE. Bank Height:	2.7	feet
bank to bank Eroding Seg. Length	236	feet
Percent eroding bank	0.08	
Bank erosion over sampled reach (E)	4	tons/year/sample reach
Erosion Rate (ER)	15	tons/mile/year
Feet of Similar Stream Type	41184	feet*
Eroding bank extrapolation	6651.46	feet
Total stream bank erosion	**117**	tons/year
Inv. bank to bank length (LBB)	3030	feet
	(Inventoried stream length X 2)	

*Similar stream type = Strahler 2nd order streams in ID17040104SK008_02

Total Inventoried Bank Length	Erosive Bank Lngth	Average Bank Slope Hgt	Bank Material	Recession Rank
1515	32.8	2.0	Gravel	5
	16.4	1.3		
	4.9	0.7		
	9.8	1.6		
	6.6	0.7		
	6.6	2.0		
	16.4	2.3		
	6.6	3.3		
	9.8	2.6		
	16.4	3.3		
	6.6	2.6		
	4.9	2.6		
	8.2	2.0		
	6.6	0.7		
	13.1	1.3		
	6.6	1.3		
	19.7	4.6		
	6.6	6.6		
	6.6	6.6		
	4.9	6.6		
	19.7	1.0		
	6.6	3.3		
1515	236.2	2.7	sec. total	5
			Recession Rate	0.06
Total Inventoried Length	Total Erosive Length			
1515	236.2	2.7	Ave. Rec.Rank	5
			Ave. Rec.Rate	0.06

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	5	tons/year/sample reach
Erosion Rate (ER)	19	tons/mile/year
Feet of Similar Stream Types	41184.00	feet
Eroding bank extrapolation	17079.60	feet
Total stream bank erosion	**150.5**	tons/year

Eroding Area	Reach erosion rate		Eroding Area with Load Reductions	Load Capacity	
1261.138967	4.162	tons/year	1617.7	5.338	tons/year
Recession Rate			Recession Rate		
0.06			0.06		
Bulk Density			Bulk Density		
110			110	Total for segments after reduction	
	4.162	tons/year		5.338	tons/year/sample
	Current loading rate			Load Allocation	
Eroding Area	**Average Reach erosion rate**			**Total Reduction**	
1261	4.162	**tons/year/sample**		-1.177	**tons/year/sample**
Recession Rate					
0.06					
Avg. Bulk Density					
110					

Figure C9. Indian Creek (Fall Creek Road) streambank erosion inventory worksheet.

Stream Bank Erosion Inventory Worksheet	
Stream	North Fork Pine Creek
Section	
Land Use	Forest/Recreation
Field Crew	Aaron Swift, Jack Rainey

Stream Segment Location		
GPS Coordinates		
Upstream	N 43.56056	
	W 111.27572	
Downstream	N 43.56343	
	W 111.27544	

Stream Bank Erosion Calculations		
AVE. Bank Height:	1.0	feet
bank to bank Eroding Seg. Length	63	feet
Percent eroding bank	0.02	
Bank erosion over sampled reach (E)	0	tons/year/sample reach
Erosion Rate (E_R)	1	tons/mile/year
Feet of Similar Stream Type	84480	feet*
Eroding bank extrapolation	3611.16	feet
Total stream bank erosion	**12**	tons/year
Inv. bank to bank length (L_{BB})	3000	feet
	(Inventoried stream length X 2)	

*Similar stream type = Strahler 2nd order streams in ID17040104SK029_03

Individual Bank Measurements				
Total Inventoried Length	Bank Erosive Bank Lngth	Average Bank Slope Hgt	Bank Material	Recession Rank
1500	36.1	1.0	Cobble	2
	26.2	1.0		
1500	62.3	1.0	sec. total	2
			Recession Rate	0.03
Total Inventoried Length	Total Erosive Length			
1500	62.3	1.0	Ave. Rec.Rank	2
			Ave. Rec.Rate	0.03

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	2	tons/year/sample reach
Erosion Rate (E_R)	7	tons/mile/year
Feet of Similar Stream Types	84480.00	feet
Eroding bank extrapolation	34392.00	feet
Total stream bank erosion	**113.5**	tons/year

Eroding Area	Reach erosion rate		Eroding Area with Load Reductions	Load Capacity	
124.67192	0.206	tons/year	600.0	1.980	tons/year
Recession Rate			Recession Rate		
0.03			0.06		
Bulk Density			Bulk Density		
110			110	Total for segments after reduction	
	0.206	tons/year		1.980	tons/year/sample
	Current loading rate			Load Allocation	
Eroding Area	**Average Reach erosion rate**			**Total Reduction**	
125	0.206	**tons/year/sample**		-1.774	**tons/year/sample**
Recession Rate					
0.03					
Avg. Bulk Density					
110					

Figure C10. North Fork Pine Creek streambank erosion inventory worksheet.

Stream Bank Erosion Inventory Worksheet	
Stream	Black Canyon Creek
Section	
Land Use	Forest/Recreation
Field Crew	Aaron Swift, Jack Rainey

Stream Segment Location		
GPS Coordinates		
Upstream	N 43.58718	
	W 111.461893	
Downstream	N 43.588503	
	W 111.453905	

Stream Bank Erosion Calculations		
AVE. Bank Height:	1.0	feet
bank to bank Eroding Seg. Length	62	feet
Percent eroding bank	0.02	
Bank erosion over sampled reach (E)	0	tons/year/sample reach
Erosion Rate (E_R)	1	tons/mile/year
Feet of Similar Stream Type	4552	feet*
Eroding bank extrapolation	250.15	feet
Total stream bank erosion	**1**	tons/year
Inv. bank to bank length (L_{BB})	3000	feet
(Inventoried stream length X 2)		
*Similar stream type = Strahler 2nd order streams in ID17040104SK030_02		

Individual Bank Measurements

Total Inventoried Length	Bank Erosive Bank Lngth	Average Bank Slope Hgt	Bank Material	Recession Rank
1500	36.1	1.0	Cobble	2
	26.2	1.0		
1500	62.3	1.0	sec. total	2
			Recession Rate	0.03
Total Inventoried Length	Total Erosive Length			
1500	62.3	1.0	Ave. Rec.Rank	2
			Ave. Rec.Rate	0.03

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	2	tons/year/sample reach
Erosion Rate (E_R)	7	tons/mile/year
Feet of Similar Stream Types	4552.00	feet
Eroding bank extrapolation	2420.80	feet
Total stream bank erosion	**8.0**	tons/year

Eroding Area	Reach erosion rate		Eroding Area with Load Reductions	Load Capacity	
124.67192	0.206	tons/year	600.0	1.980	tons/year
Recession Rate			Recession Rate		
0.03			0.06		
Bulk Density			Bulk Density		
110			110	Total for segments after reduction	
	0.206	tons/year		1.980	tons/year/sample
	Current loading rate			Load Allocation	
Eroding Area	**Average Reach erosion rate**			**Total Reduction**	
125	0.206	**tons/year/sample**		-1.774	**tons/year/sample**
Recession Rate					
0.03					
Avg. Bulk Density					
110					

Figure C11. Black Canyon Creek streambank erosion inventory worksheet.

References

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Appendix D. Bacteria Data—Idaho Falls Regional Office

State of Idaho, Department of Health and Welfare
Bureau of Laboratories - Pocatello Branch Lab
465 Memorial Drive, Pocatello, Idaho 83201
NON DRINKING WATER - BACTERIAL DENSITY REPORT

LAB: POCATELLO, Phone: (208) 233-4341
Branch Laboratory Supervisor, Bacteriology: Ardith Moran

DEQ-IDAHO FALLS
STEVE ROBINSON
900 N. SKYLINE SUITE B
IDAHO FALLS, ID 83402

Tracking Number: 60899-6298/
(Please Refer to this Tracking Number on any communications)

Grant/Project: 8709
BURP
Storet:
NPDES Number:
Matrix: WATER
Sample Location: RAINEY CK 98-E008 1998-SIDF E008
Type of Sample: Grab, Surface
Sample Taken From: Creek - C
Collected by: ROBINSON CREW
Preservation: Sodium Thiosulfate AND Cooled, 4½ C

Date Collected: 08/12/99 Date Received in Lab: 08/12/99
Time Collected: 10:00 Time Received in Lab: 14:30

Copy Sent To: DIST. 7 HD, ENVIRONMENTAL DIV.
ëëë

TEST CODE áááá		RESULTS ááááááá	COMPLETED ááááááááá
EQT	TOTAL COLIFORM	4900 /100 ml	08/13/99
EQM	E. COLI	470 /100 ml.	08/13/99
EMFC	FECAL COLIFORM (STORET # 31616)	480 /100 ml.	08/13/99

RECEIVED
AUG 16 1999
DEQ-IDAHO FALLS

State of Idaho, Department of Health and Welfare
Bureau of Laboratories - Pocatello Branch Lab
465 Memorial Drive, Pocatello, Idaho 83201
NON DRINKING WATER - BACTERIAL DENSITY REPORT

LAB: POCATELLO, Phone: (208) 233-4341
Branch Laboratory Supervisor, Bacteriology: Ardith Moran

STEVE ROBINSON

,

Tracking Number: 60899-6419/
(Please Refer to this Tracking Number on any communications)

Grant/Project:	8709 BURP
Storet:	
NPDES Number:	
Matrix:	WATER
Sample Location:	RAINEY CK 98-E008 1998 SIDF E008
Type of Sample:	Grab, Surface
Sample Taken From:	Creek - C
Collected by:	ROBINSON CREW
Preservation:	Sodium Thiosulfate AND Cooled, 4½ C

Date Collected: 08/16/99 Date Received in Lab: 08/17/99
Time Collected: 11:10 Time Received in Lab: 14:30
ëë

TEST CODE áááá		RESULTS ááááááá	COMPLETED ááááááááá
EQT	TOTAL COLIFORM	1100 /100 ml	08/19/99
EQM	E. COLI	100 /100 ml.	08/19/99
EMFC	FECAL COLIFORM (STORET # 31616)	90 /100 ml.	08/19/99

RECEIVED
AUG 19 1999
DEQ-IDAHO FALLS

State of Idaho, Department of Health and Welfare
Bureau of Laboratories - Pocatello Branch Lab
465 Memorial Drive, Pocatello, Idaho 83201
NON DRINKING WATER - BACTERIAL DENSITY REPORT

LAB: POCATELLO, Phone: (208) 233-4341
Branch Laboratory Supervisor, Bacteriology: Ardith Moran

STEVE ROBINSON

,

Tracking Number: 60899-6518/
(Please Refer to this Tracking Number on any communications)

Grant/Project:	8709 BURP
Storet:	
NPDES Number:	
Matrix:	WATER
Sample Location:	RAINEY CK 98-E008 1998 SIDF E008
Type of Sample:	Grab, Surface
Sample Taken From:	Creek - C
Collected by:	ROBINSON CREW
Preservation:	Sodium Thiosulfate AND Cooled, 4½ C

Date Collected: 08/19/99 Date Received in Lab: 08/19/99
Time Collected: 11:00 Time Received in Lab: 15:20
ëë

TEST CODE áááá		RESULTS ááááááá	COMPLETED ááááááááá
EQT	TOTAL COLIFORM	4600 /100 ml	08/20/99
EQM	E. COLI	780 /100 ml.	08/20/99
EMFC	FECAL COLIFORM (STORET # 31616)	800 /100 ml.	08/20/99

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AUG 23 1999
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State of Idaho, Department of Health and Welfare
Bureau of Laboratories - Pocatello Branch Lab
465 Memorial Drive, Pocatello, Idaho 83201
NON DRINKING WATER - BACTERIAL DENSITY REPORT

LAB: POCATELLO, Phone: (208) 233-4341
Branch Laboratory Supervisor, Bacteriology: Ardith Moran

DEQ-IDAHO FALLS
STEVE ROBINSON
900 N. SKYLINE, SUITE B
IDAHO FALLS, ID 83402

Tracking Number: 60899-6693/
(Please Refer to this Tracking Number on any communications)

Grant/Project:	8709 BURP
Storet:	
NPDES Number:	
Matrix:	WATER
Sample Location:	RAINEY CR. 98-008 1998-SIDF E008
Type of Sample:	Surface
Sample Taken From:	Creek - C
Collected by:	STEVE ROBINSON CREW
Preservation:	Sodium Thiosulfate

Date Collected: 08/26/99 Date Received in Lab: 08/26/99
Time Collected: 11:00 Time Received in Lab: 16:00

TEST CODE		RESULTS	COMPLETED
EQT	TOTAL COLIFORM	11,000 /100 ml	08/27/99
EQM	E. COLI	110 /100 ml.	08/27/99
EMFC	FECAL COLIFORM (STORET # 31616)	120 /100 ml.	08/27/99

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AUG 30 1999
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State of Idaho, Department of Health and Welfare
Bureau of Laboratories - Pocatello Branch Lab
465 Memorial Drive, Pocatello, Idaho 83201
NON DRINKING WATER - BACTERIAL DENSITY REPORT

LAB: POCATELLO, Phone: (208) 233-4341
Branch Laboratory Supervisor, Bacteriology: Ardith Moran

STEVE ROBINSON

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Tracking Number: 60899-6580/
(Please Refer to this Tracking Number on any communications)

Grant/Project:	8709 BURP
Storet:	
NPDES Number:	
Matrix:	WATER
Sample Location:	RAINEY CK 98-E008 1998- SIDF E008
Type of Sample:	Grab, Surface
Sample Taken From:	Creek - C
Collected by:	ROBINSON CREW
Preservation:	Sodium Thiosulfate AND Cooled, 4½ C

Date Collected: 08/23/99 Date Received in Lab: 08/24/99
Time Collected: 10:20 Time Received in Lab: 14:30
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TEST CODE áááá		RESULTS ááááááá	COMPLETED ááááááááá
EQT	TOTAL COLIFORM	1700 /100 ml	08/26/99
EQM	E. COLI	80 /100 ml.	08/26/99
EMFC	FECAL COLIFORM (STORET # 31616)	150 /100 ml.	08/26/99

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Appendix E. Distribution List

Copies of the final report will be provided to the Idaho Department of Environmental Quality State Office, US Environmental Protection Agency Region 10, and South Fork Snake WAG chairman as well as the following agencies, nongovernmental organizations, and public commenters:

Mark Lovell
WAG Chairman
Ririe, ID

Brett High
Idaho Department of Fish and Game
Idaho Falls, ID

Brad Higginson
United States Forest Service, Caribou-Targhee National Forest
Idaho Falls, ID

Dan Kotansky
Bureau of Land Management
Idaho Falls, ID

Matt Woodard
Trout Unlimited
Idaho Falls, ID

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Appendix F. Public Comments/Public Participation

The South Fork Snake WAG played an integral part in helping with the TMDL addendum. DEQ held WAG meetings in spring and fall 2011 to let WAG members express their concerns with ongoing issues in the Palisades Subbasin. DEQ also presented the TMDL addendum and 5-year review to the Upper Snake Basin Advisory Group (BAG) in spring 2012. The BAG did not express major concerns and were pleased with the document.

Public Comments and Responses

The public comment period for the Palisades Subbasin TMDL 2013 Addendum and Five Year Review was initiated April 30, 2013, with a deadline for submitting comments set for 5 p.m. MDT on May 30, 2013. Notice of the request for public comments was published in the Idaho Falls *Post Register*, the Jefferson County *Jefferson Star*, and on the DEQ website: deq.idaho.gov. No public comments were received during the 30 day public comment period.

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